PB89-204739

Superfund Record of Decision (EPA Region 1) Charles George Landfill, Massachusetts (Third and Fourth Remedial Actions), September 1988

(U.S.) Environmental Protection Agency, Washington, DC

29 Sep 88

U.S. Department of Commerce
National Technical Information Service
NTIS

United States
Environmental Protection
Agency

Office of
Emergency and
Remedial Response

EPA/ROD/R01-88/029
September 1988

PB89-204739

EPA

Superfund Record of Decision:

Charles George Landfill, MA

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U.S. DEPARTMENT OF COMMERCE
NATIONAL TECHNICAL INFORMATION SERVICE
SPRINGFIELD, VA. 22161

50272-101

REPORT DOCUMENTATION PAGE

1. REPORT NO. EPA/ROD/R01-88/029

2.

3. Recipient's Accession No.

4. Title and Subtitle
SUPERFUND RECORD OF DECISION
Charles George Landfill, MA
Third and Fourth Remedial Actions - Final

5. Report Date 09/29/88

6.

7. Author(s)

8. Performing Organization Rept. No

9. Performing Organization Name and Address

10. Project/Task/Work Unit No.

11. Contract(C) or Grant(G) No.
(C)
(G)

12. Sponsoring Organization Name and Address
U.S. Environmental Protection Agency
401 M Street, S.W.
Washington, D.C. 20460

13. Type of Report & Period Covered
800/000

14.

15. Supplementary Notes

16. Abstract (Limit: 200 words)

The Charles George Landfill (CGL) site is located approximately one mile southwest of the Town of Tyngsborough, Massachusetts. The 70-acre site is bounded by Flint Pond Marsh (wetland area) and Flint Pond to the east, Dunstable Brook to the west, and the Cannongate Condominium complex to the southeast. Land use in the vicinity of the site is predominantly rural and residential but also includes some light industry and seasonal livestock grazing. The landfill contains municipal waste disposed of onsite from the mid-1950s until the landfill closed in 1983 by order of the Massachusetts Attorney General. Hazardous industrial waste was also disposed of primarily in the western area of the site from 1973 until at least 1976. The site came to the attention of the Massachusetts Department of Environmental Quality Engineering (DEQE) when the deep bedrock wells in use by the Cannongate Condominium complex became contaminated with VOCs. The DEQE ordered the wells closed in 1982. EPA conducted ground water monitoring in 1981 and 1982, and also undertook emergency removal actions beginning in August 1983 and continuing through March 1984. Presently the site has a thin soil cover, 2 surface water and leachate lagoons, 2 leachate collection systems, 1 recirculating pump station, and 12 shallow gas vents. Construction of a full synthetic landfill cap was addressed in a previous ROD and should begin in early 1989. This ROD encompasses the third and
(See Attached Sheet)

17. Document Analysis a. Descriptors
Record of Decision
Charles George Reclamation, MA
Third and Fourth Remedial Action - Final
Contaminated Media: air, gw, sediments
Key Contaminants: metals (arsenic), organics (PAHs), VOCs (Benzene, TCE)

b. Identifiers/Open-Ended Terms

c. COSATI Field/Group

18. Availability Statement

19. Security Class (This Report) None

20. Security Class (This Page) None

21. No. of Pages 111

22. Price

(See ANSI–Z39.18)

See Instructions on Reverse

OPTIONAL FORM 272 (4–77)
(Formerly NTIS–35)
Department of Commerce

16. ABSTRACT (continued)

fourth operable units and focuses on the control and cleanup of contaminants that have spread or are spreading from the site, including the treatment of leachate collected as part of the cap system. Investigations have identified contaminated ground water in overburden, shallow bedrock, and deep bedrock zones. In addition, an estimated 500 yd^3 of sediments require remediation, and vent emissions from the landfill are contaminated with a wide array of VOCs. The primary contaminants of concern affecting the ground water, sediments and air, are VOCs including benzene and TCE, organics including PAHs, and metals including arsenic.

The selected remedial action for this site includes: extraction and treatment of shallow ground water plumes and leachate collected from the landfill cap system using biological treatment, metals precipitation and carbon adsorption with onsite discharge of the treated water into the aquifer or offsite discharge into nearby surface water; collection and incineration of landfill vent gas emissions; excavation and solidification of approximately 500 yd^3 of contaminated Dunstable Brook sediments and placement beneath the Phase II landfill cap; and ground water monitoring. The estimated present worth cost for this remedial action is $11,320,000 which includes O&M costs of $601,000.

Record of Decision
Remedial Alternative Selection

Site Name and Location

Charles George Reclamation Landfill
Tyngsborough, Massachusetts

State of Purpose

This Decision Document represents the selected phase III remedial actions for this site developed in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA), and to the extent practicable, the National Contingency Plan (NCP); 40 CFR Part 300 et seq., 47 Federal Register 31180 (July 16, 1982), as amended.

The Commonwealth of Massachusetts has concurred with the selected remedies of this document.

Statement of Basis

This decision is based on the administrative record for the site which was developed in accordance with Section 113(k) of CERCLA and which is available for public review at information repositories located in the Littlefield Public Library, Tyngsborough, Massachusetts, and at 90 Canal St., Boston, Massachusetts. The attached index to the administrative record identifies the documents upon which the selection of the phase III remedial actions are based.

Description of the Selected Remedy

The selected remedies for the phase III cleanup at the Charles George site represent the remaining cleanup measures anticipated to be necessary. These phase III remedial actions consist of:

1. Extraction of contaminated southwestern and eastern shallow groundwater plumes, and combined biological-based treatment of the extracted groundwater with leachate collected from the landfill cap system;

2. Deep bedrock groundwater and residential well monitoring;

3. Collection and incineration of landfill vent gas emissions; and

4. Excavation and solidification of approximately 500 cubic yards of contaminated Dunstable Brook sediments. The solidified sediments will be placed on the existing Charles

George landfill for capping as part of the phase II, source control remedy for the site.

The estimated present worth costs for these remedies, including design, construction, and operating costs, and assuming thirty years for remediation, are $8,800,000, $1,301,000, $1,034,000 and $79,000, respectively. The total estimated present worth cost for the phase III remedies is $11,320,000.

Declaration

The selected phase III remedies are protective of human health and the environment. These remedies satisfy the statutory preference for treatment that permanently and significantly reduces the volume, toxicity and mobility of the hazardous substances, pollutants and contaminants as a principal element. They also utilize permanent solutions and alternative treatment technologies to the maximum extent practicable, and are cost-effective. Except for the attainment of Safe Drinking Water Act maximum concentration limits (MCLs) in eastern deep bedrock groundwater at and near the site, these remedies attain Federal and State requirements that are applicable or relevant and appropriate (ARARs).

Finding under Section 121(d)(4)(C)

As discussed in more detail in the summary document to this Record of Decision, the attainment of MCL ARARs in the residual eastern deep bedrock plume has been found to be technically impracticable. Primarily, this is because of the difficulty in predicting groundwater flow in bedrock, and thus the difficulty in defining the spatial extent of bedrock contamination. Also, extraction pumping of the site's eastern deep bedrock aquifer could increase contaminant migration by drawing shallow groundwater contaminants into bedrock groundwater. For further discussion, please see Chapters 6, 7, 11, and 12 of the Remedial Investigation (Ebasco, 1988), Chapter 7 of the Feasibility Study (Ebasco, 1988), and sections V.A and XI.A of the summary document to this Record of Decision.

9/29/88
Date

Michael R. Deland
Regional Administrator, EPA Region I

CHARLES GEORGE RECLAMATION LANDFILL
SUMMARY OF PHASE III
RECORD OF DECISION

ENVIRONMENTAL PROTECTION AGENCY
REGION I

SEPTEMBER 29, 1988

CHARLES GEORGE RECLAMATION LANDFILL
RECORD OF DECISION SUMMARY

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CHARLES GEORGE RECLAMATION LANDFILL
SUMMARY OF PHASE III
RECORD OF DECISION

I. SITE LOCATION AND DESCRIPTION

The Charles George Reclamation Landfill (CGL) is a seventy acre mixed industrial, municipal and hazardous waste landfill located approximately one mile southwest of the Town of Tyngsborough, Massachusetts. See Figure 1. Land use in the vicinity of the site is predominantly rural residential but also includes some light industry and seasonal livestock grazing. Drinking water is supplied by groundwater as well as a new water main installed as a result of the Environmental Protection Agency's (EPA's) first Record of Decision (ROD) for the site. The site is bordered to the east by U.S. Route 3, Flint Pond Marsh and Flint Pond, respectively. Dunstable Road and Dunstable Brook border to the west, and the Cannongate Condominium complex is about 800 feet to the southeast. Blodgett Street forms the northwest border, eventually becoming Cummings Road further north of the landfill.

Figure 1 also shows the residential areas near the site and the route of the new water main. In addition to the condominium's ninety-six units, there are homes along Cannongate Road, Dunstable Road, Red Gate Road and Blodgett/Cummings Road. Residences on Red Gate Road, Dunstable Road north of Cannongate Road, and Blodgett/Cummings Road are not served by the water main. Across Flint Pond, a neighborhood is located on the Pond's northern peninsula about one-half mile from the site. The Academy of Notre Dame is on the eastern shore of Flint Pond, and the town center of Tyngsborough is at the northeast corner of Flint Pond.

The landfill itself contains hazardous industrial waste disposed primarily in the western area of the site from 1973 until at least 1976. Municipal waste was disposed onsite from the mid 1950's until the landfill's closing, per order of the Massachusetts Attorney General, in 1983. Presently the site has a thin soil cover, and it contains two combined surface water and leachate lagoons, two leachate collection systems, one operable recirculating pump station, and twelve shallow gas vents. The site's existing condition is described further in pages 2-2 through 2-6 of the Remedial Investigation (RI) (Ebasco/E.C. Jordan Co., 1988) and pages 1-2 through 1-3 of the Feasibility Study (FS) (Ebasco/E.C. Jordan Co., 1988).

Construction of a full synthetic landfill cap, pursuant to EPA's second ROD for the site, should begin in early 1989. The cap design includes a shallow perimeter leachate toe-drain, four leachate storage tanks, a passive gas collection and venting system, and a surface water diversion and sedimentation system.

Surficial geologic deposits at the CGL consist of stratified sand and gravel in the eastern area of the site, and silty glacial till deposits to the west. Unconsolidated surficial deposits overlie fractured biotite-gneiss bedrock in which quartzite sills have intruded. In the eastern area of the site, landfill refuse rests on bedrock, and to the west, more than 20 feet of silty till lie between refuse and bedrock.

Three general zones of groundwater underlie the area: saturated overburden, shallow weathered bedrock, and deep bedrock. Overburden and shallow bedrock groundwater gradients indicate water movement away from the landfill in all directions except north. Two plumes of contaminated shallow groundwater have been found to be currently moving to the east and southwest. Shallow aquifers in these areas discharge to Flint Pond Marsh and Dunstable Brook, respectively. Some refuse lies beneath the current early-spring water table in all areas of the landfill. The saturated thickness of the refuse varies from negligible in the east to over ten feet in the western area.

Contaminated groundwater in the eastern part of the site was previously pulled southward and into deep bedrock from 1975 through 1982 when Cannongate's deep bedrock wells were in use. The condominium's wells, 500 feet deep in bedrock, became contaminated with volatile organic compounds (VOC's) as a result, and were ordered closed by the Massachusetts Department of Environmental Quality Engineering (DEQE) in 1982. Deep bedrock groundwater remains contaminated in the Cannongate area and northward to the landfill's eastern boundary at approximate depths of 150-400 feet below ground surface. Since the cessation of Cannongate's pumping, deep groundwater gradients have reverted to an easterly direction at an estimated velocity of 20 feet per year. More information on site characteristics, including air emissions and sediment contamination is included in section five of this ROD.

II. Site Response & Enforcement History

A. Response History

EPA's involvement at the CGL began with groundwater testing, conducted by EPA contractor Ecology and Environment, Inc. during 1981 and 1982. EPA also undertook emergency removal actions beginning in August 1983 and continuing through March 1984. These actions included the replacement of DEQE's temporary waterline to Cannongate with another temporary but insulated waterline from the North Chelmsford Water District. Other removal work included construction of a security fence along the northwestern entrance to the landfill, regrading and placement of soil cover over exposed refuse, and installation of twelve gas vents.

As mentioned earlier, EPA has issued two previous RODs for remedial operable units at the site. The first ROD, issued in December 1983, selected an extension of an existing water supply system to serve the Cannongate area. The new water line, an extension of the City of Lowell's system, should be activated in the Fall of 1988. The second ROD, issued in July 1985, selected a full synthetic membrane landfill cap with surface water diversion, off-gas collection and venting, and leachate seep collection. The design for the cap and appurtenant systems has been completed, and construction should begin in early 1989.

During its involvement with the CGL, EPA has undertaken various site investigations and feasibility studies to explore the extent and effects of contamination at the site and to evaluate alternative remedies for each phase of cleanup. These studies, listed chronologically, include:

1. Preliminary Site Assessment, (February 1981, Ecology and Environment, Inc.)

2. Field Investigations of Uncontrolled Hazardous Waste Sites, Charles George Land Reclamation Trust, Final Report (December 1982, Ecology and Environment, Inc.)

3. Water Supply Alternatives, Cannongate Area, Tyngsborough, Massachusetts
    a. Part 2 of 2 (September 1983, Fay Spofford & Thorndike, Inc.)
    b. Part 1 of 2 (October 1983, NUS)

4. Remedial Action Master Plan (November 1983, NUS)

5. Source-Oriented Feasibility Study
    a. Draft - March 1985, NUS
    b. Final - November 1985, NUS

6. Feasibility Study on Treatment of Leachate from Charles George Landfill (February 1986, Camp Dresser and McKee, Inc.)

7. Wetlands Assessment, Charles George Landfill Site (June 1986, GCA Corp.)

8. Preliminary Remedial Investigation Report, Charles George Site, Volumes I and II, (September 1986, NUS)

9. Endangerment Assessment, Charles George Landfill (January 1987, Planning Research Corp./Alliance Technologies Corp.)

10. Remedial Investigation Report, Charles George Landfill Site, Volumes I and II (July 1988, Ebasco/E.C. Jordan)

11. Feasibility Study Report, Charles George Landfill Site (July 1988, Ebasco/E.C. Jordan)

More information on EPA's cleanup history at the site can be found on page 2-6 of the RI and page 1-3 of the FS.

B. Enforcement history

In 1982, 1983 and 1985, EPA notified parties who owned or operated the landfill, arranged for the disposal of wastes at the landfill, or transported wastes to the landfill, of their potential liability with respect to the CGL. Information request letters were sent to six of these parties in March 1984. In 1986, EPA notified fifty-two additional parties who generated wastes that were shipped to the facility of their potential liability with respect to the site.

The 52 potentially responsible parties (PRPs) have formed a steering committee to represent them in their dealings with EPA. The members of the Committee have been in close contact with EPA since the Committee's inception by way of letters, telephone conversations and meetings. Through said Committee, the PRPs have been involved in the legal and technical discussion of the cleanup work at the site.

The Steering Committee's technical subcommittee has met regularly with EPA and DEQE, and has gained a full understanding of the existing conditions at the site and the preferred cleanup alternatives. Through these meetings the technical subcommittee has presented to EPA and DEQE their ideas on cleanup alternatives. In addition, the PRPs have submitted technical comments to EPA during the public comment period. These comments have been included in the administrative record for the site.

EPA has been in litigation with the first six noticed PRPs since June 1985 for reimbursement of response costs, declaratory judgement for future liability, voidance of fraudulent real estate conveyances, and access to the site for implementation of the second ROD. An access Order was issued by the court providing for access to the site and surrounding properties by EPA and DEQE for the implementation of the source-control (landfill capping) remedy.

III. Community Relations

Through the site's history, community concern and involvement has been high. EPA has kept the community and other interested parties apprised of the site activities through informational meetings, fact sheets, press releases and public meetings. Since March 1988, EPA and the DEQE have met monthly with the local citizens advisory committee.

In August 1987, EPA released a revised community relations plan which outlines programs to address community concerns and to keep citizens informed about and involved in activities during remedial activities. The plans for the most recent RI and FS were originally described at an informational meeting in Tyngsborough on November 20, 1986.

The Agency published a public notice of upcoming public meetings and a brief analysis of the Proposed Plan in both the Lowell Sun and the Chelmsford Newsweekly on July 26 and July 28, 1988, respectively. The Proposed Plan was also mailed out to 310 parties on EPA's mailing list for the site on July 21, 1988. On July 22, 1988 the FS was made available to the public at the Littlefield Public Library and at the Tyngsborough Town Hall. Both volumes of the RI (narrative and appendices) were made available to the public at the Littlefield Public Library by August 4, 1988.

On August 3, 1988 EPA held a public informational meeting to discuss the results of the RI and the cleanup alternatives presented in the FS, as well as to present the Agency's Proposed Plan. EPA also answered questions from the public during this meeting. From August 4 through August 24, 1988 the Agency held a three week public comment period to accept public comment on the alternatives presented in the FS and the Proposed Plan and on any other documents previously released to the public. On August 17, 1988, the Agency held an informal public hearing to accept any oral comments. No oral comments were given at this hearing, but EPA again explained the Proposed Plan and answered further questions. A transcript of this hearing, and the Agency's responses to written comments are included in the attached responsiveness summary.

IV. Scope and role of operable units and brief description of the selected remedy

This ROD encompasses both the third and fourth operable units for the CGL as defined by EPA. As such, the selected remedial actions of this ROD represent the third and final phase of anticipated cleanup at the site. The operable units for the site have been defined as follows:

1. Provide alternative water supply for the Cannongate area;
2. Control the source of contamination at the site;
3. Control the migration of contaminants from the site; and
4. Treat leachate collected as a result of the selected source control remedy.

Thus the focus of this ROD is on the control and cleanup of contaminants that have spread or are spreading from the site, including the treatment of leachate collected as part of the cap system. Based on the evaluation criteria and viable options discussed in detail in sections VIII-XII of this document, EPA selected the three part remedy outlined below for the cleanup of contaminated groundwater and leachate, landfill gas emissions and stream sediment. The remedy is presented here to provide focus for the reader during the following discussion.

1. Leachate collected from the landfill cap system will be combined with contaminated overburden and shallow bedrock groundwater and treated on site with biological treatment, hydroxide precipitation, carbon adsorption, and, if necessary, ion exchange water treatment units. The treated leachate and groundwater will be monitored and discharged into groundwater on-site, if feasible. If not, the treated leachate and groundwater will be discharged to a nearby approved surface water. An upgradient groundwater diversion trench will also be installed to assist in lowering the water table beneath the landfill, thereby minimizing direct contact between groundwater and landfill wastes. In addition, groundwater monitoring will be performed to provide early warning of possible increases in contaminant concentrations that may impact residential drinking wells in deep bedrock.

2. Landfill vent emissions will be collected and incinerated on site; and

3. Contaminated sediments in Dunstable Brook immediately west of the landfill will be dredged, solidified on site, and placed beneath the full synthetic cap that will be constructed over the landfill per EPA's second ROD.

As mentioned previously, construction of the landfill cap should begin in early 1989. Collection of leachate could thus begin by the end of 1989. Since it is possible that the phase III remedy for leachate treatment will not be designed, constructed and implemented within this time frame, some method of interim leachate treatment and disposal may be required.

V. Site Characteristics

Section 3-3 of the FS contains an overview of the Remedial Investigation, including the quantity and concentrations of contaminants in groundwater, leachate, brook sediments and landfill gas emissions. The significant findings of the RI are summarized below.

A. Groundwater

The RI identified three areas of contaminated groundwater which warranted consideration for remedial action. These consist of overburden groundwater in the southwestern area of the site; overburden and shallow bedrock groundwater in the eastern area of the site; and deep bedrock groundwater 150-450 feet deep in a north-south plume stretching from the northeast boundary of the landfill to the Cannongate area. These plumes are illustrated in Figure 2, and the maximum contaminant concentrations found in each plume during the 1987 remedial investigation are shown in Table 1. Table 1 also lists concentrations of organic compounds detected in southwestern shallow bedrock. The following paragraphs describe these areas further.

1. Southwestern overburden and shallow bedrock groundwater

In overburden, the plume travels laterally relatively slowly at an estimated 20-70 feet per year, and has been detected about 500 feet southwest of the landfill to the E & E/FIT 5 well area. Depth to bedrock ranges from 10 to 20 feet, and surficial deposits range from sandy glacial till to silty glacial till. Contaminant levels in overburden measured during 1987 were approximately 50 percent lower than historical levels, with the exception of benzene. Data indicate a trend of increasing overburden benzene levels, from 31 ug/l in 1985 to 229 ug/l in 1987.

Shallow bedrock groundwater sampled from well MW-8 exhibits organic contamination similar to overburden groundwater, with the exception of benzene. Data from the one 1987 sample from well MW-8 indicate an estimated benzene concentration of 8 ug/l. Although MW-8 was analyzed for total metals rather than dissolved, arsenic contamination appears to be less in shallow bedrock than overburden (26 ug/l total verses 249 ug/l dissolved, respectively). Shallow bedrock is characterized by small opening fractures rather than large, high yield fractures, and its potentiometric surface (Figure 7-6 of the RI) strongly resembles the overburden water table (Figure 7-4 of the RI). Contaminants in overburden and shallow bedrock aquifers are expected to discharge primarily upward toward Dunstable Brook, but some contaminated groundwater may pass beneath Dunstable Brook and discharge at a more distant location from the landfill. Deep bedrock groundwater (greater than 100 feet deep) is not believed to be within the contaminant flow path.

Potential receptors include future well users living in or near the now abandoned Hoare residence, and the biological communities associated with the stream system across Dunstable Road. Leachate seepage contributing to groundwater contamination in this plume will be minimized once the landfill is capped, but if portions of the refuse remain saturated the refuse will continue to be a chronic source of contamination.

2. Eastern overburden and shallow bedrock groundwater

Groundwater in the 20 foot thick sand and gravel overburden aquifer underlying the eastern area travels laterally at approximately 220 feet per year. This flow system discharges to the Route 3 drainage system, Flint Pond Marsh, and possibly to Flint Pond. The Route 3 drainage system ultimately discharges to Flint Pond Marsh. Adequate time has already passed for groundwater contamination to reach the Marsh and Pond. Present contaminant concentrations in this aquifer are relatively low, but deterioration and leakage of waste containers within the landfill could cause contaminant concentrations to fluctuate markedly. In the northeastern area of the landfill some refuse is saturated by groundwater, but groundwater that just penetrates into the base of refuse in the eastern area did not flow in sufficient quantities to allow sampling. The closest drinking water wells to this plume are located in the residential area on the northeast shore of Flint Pond. Adverse impacts to these wells from CGL contaminants are unlikely since contaminant concentrations in the plume moving towards Flint Pond are low. Whatever contaminants that do discharge into the pond are expected to be below detection limits. Evidence for this is given by the results of the residential drinking well and surface water monitoring discussed in sections V.C and V.F of this document, respectively.

As Table 1 shows, shallow bedrock groundwater in the lightly fractured zone at the top of the bedrock in this area is also contaminated, at levels significantly higher than in the surficial deposits. Although predicting specific routes of contaminant transport in bedrock is difficult, water level data gathered for overburden, shallow and deep bedrock monitoring wells suggest that hydraulic gradients are downward at the eastern edge of the landfill and upward in the vicinity of Flint Pond. Bedrock groundwater would only be anticipated to discharge to Flint Pond Marsh or Flint Pond if conductive fractures penetrate deep bedrock zones with sufficient upward groundwater gradients.

3. Eastern deep bedrock groundwater

Contamination in deep bedrock groundwater exists along the eastern edge of the landfill south to the Cannongate area at depths from 150 to over 450 feet below ground surface. As mentioned earlier, this plume was drawn down and southward by the Cannongate condominium wells. Natural eastward gradients and flow rates of approximately 20 feet per year have been reestablished since the condominium wells' inactivation in 1982.

Existing receptors in the Cannongate area will be eliminated with the activation of the new water main. Identifying future receptors is difficult due to the uncertainties associated with predicting specific avenues of contaminant transport in bedrock, and future pumping effects from outside of the immediate CGL area.

Deep groundwater is not expected to rise at a steep enough gradient to enter Flint Pond or the overburden aquifer, given the low upward hydraulic gradient at well JDT-2. Some private deep bedrock wells do exist along Middlesex Road over 4000 feet to the east of the site, but contaminant concentrations should decrease significantly, due to dilution, natural attention, and the expected decades of travel time, before reaching these locations. The neighborhood on the northeast shore of Flint Pond is not considered a receptor, given the east to southeast deep groundwater gradients detected along the eastern landfill boundary and the lack of groundwater contamination in the area attributable to the landfill. The Merrimack River is the inferred regional deep groundwater discharge area.

A more detailed discussion of groundwater contamination at the site can be found in Chapter 7 and section 11.2 of the RI.

B. Leachate

Above ground discharges of leachate occur at the CGL both as seepage around the site, especially at the toe-of-slope, and as discharges from the existing eastern and western collection system. The western collection system includes a pump station which recirculates the collected leachate into the western lagoon, while leachate from the eastern system drains by gravity to the eastern lagoon after by-passing an inoperable pump station. Leachate existing as seeps discharge to various small wetlands and intermittent brooks around the perimeter of the site.

Leachate from seeps and both existing collection systems will be collected as part of the capping project, and thus will no longer be a source of contamination to perimeter wetlands. This leachate will, however, as defined by EPA's operable unit four, require treatment after being collected. The leachate collection system will be above the water table, and the quantity of leachate needing treatment is estimated in the FS to be an average of 3600 gallons per day (gpd). Initially, the flow rate should be higher, but as the landfill drains down due to loss of recharge with capping this flow rate should decrease. The maximum chemical concentrations detected in leachate to date are listed in Table 2.

C. Residential drinking wells

Since 1983, EPA and the DEQE have been monitoring residential wells in the vicinity of the site to ensure that residents are not drinking contaminated well water. To date, 17 sampling rounds have been conducted which have included in total more than 100 wells located within one mile of the site. Analyses have concentrated on the detection of organic compounds, and contaminants have not been detected in most of the wells sampled to date. With the exception of a few bedrock wells in the Cannongate area, concentrations of organic compounds have all been below 10 ppb. An estimated mercury concentration of 3200 ppb in May 1985 in a shallow well north of the landfill is not considered to be site related since overburden and shallow bedrock groundwater gradients (Figures 7-4 and 7-6 in the RI) clearly demonstrate groundwater movement away from this well towards the landfill. Mercury was not detected in this area in October 1984 or May 1988.

Wells in the Flint Pond area in which organic compounds have been detected have not shown the same presence of landfill contaminants in subsequent sampling rounds. As discussed previously, these wells are not expected to be impacted by groundwater contamination from the landfill. The absence of repeat occurrences of landfill contaminants in these wells suggests sources other than the landfill.

D. Air Quality

Gaseous emissions from the landfill are generated throughout the entire site as a result of a biological and chemical processes within the refuse. This landfill gas is estimated to be 50-percent (by volume) methane, 40-percent carbon dioxide, and the remaining 10-percent a mixture of other compounds including hydrogen sulfide, mercaptans, and VOC's as listed in Table 3. The maximum on-site VOC concentrations from three sampling episodes in 1984-85, 1986 and 1987 are also listed in Table 3. The landfill gas is also characterized by a potent odor which has caused numerous complaints from residents and motorists in the area. Site observations and air sampling demonstrate that surface-based gaseous emissions can be more significant than the vent emissions.

After capping, the landfill will continue to be a source of gaseous emissions. The present cap design includes a passive, crushed stone gas collection trench system under the cap liner which will discharge to the atmosphere through twenty-eight new vents to be constructed along the top of the landfill. The twelve existing vents will be tied into the new gas collection system, and then capped below the liner. Air quality computer modeling done as part of the RI suggests that off-site impacts could decrease after capping due to increased mixing, dilution, and dispersion.

Present receptors include on-site trespassers as well as residents in the surrounding neighborhoods, including north Flint Pond. VOC concentrations detected off-site are shown in Table 4. Although the entire site will be fenced as part of the capping project, future impacts could result from on-site as well as off-site exposure. Future trespassing cannot be ruled out given the close proximity of the Cannongate neighborhood and the remote, wooded characteristics of the site boundary in that area.

E. Sediment

In the western landfill area, contaminated sediments were detected off-site in a small wetland on the northern boundary of the site and in portions of Dunstable Brook downstream of the western pump station. The small northern wetland (identified in the RI as JSED-22) receives contamination via leachate seepage and surface runoff. This area will be covered as part of the landfill capping project. Approximately 500 feet in Dunstable Brook, including a small tributary leading from the western pump station, receives contamination via leachate seepage across and under Dunstable Road and as a result of overflow from the western pump station during down times. These sources will be eliminated upon construction of the cap's leachate collection system.

The contaminants of most concern in Dunstable Brook and the tributary consist of various polynuclear aromatic hydrocarbons (PAH's) as listed in Table 5. Table 5 also lists sediment concentrations of arsenic and cadmium detected in the Dunstable Brook area. PAH's do not volatilize as readily as VOC's, and the flow regime of the Brook should not cause sediment disruption and significant downstream transport. Thus these contaminated sediments are expected to remain in place subsequent to landfill capping. The FS estimated that approximately 500 cubic yards (cy) of Brook sediments require remediation.

To the east of the landfill, contaminated sediments were detected off-site in northern Flint Pond Marsh and to a lesser extent at random sites in Flint Pond. Contamination in the Marsh sediments consisted of various metals, especially arsenic at concentrations up to 300 mg/kg, and VOC's. Flint Pond sediments in several areas contain a few VOC's and semi-volatile organic compounds (SVOC's), low concentrations of lead and chromium, and low to moderate concentrations of arsenic up to 110 mg/kg. Contaminant levels were lower in 1987 than in 1984-85 for most of the sites that were resampled. Also, similar concentrations of arsenic, lead, chromium, acetone and SVOC's in two other Tyngsborough ponds (Locust or Upton) beyond the influence of the landfill suggest high background levels or additional contaminant sources.

The discharge of shallow groundwater from the previously discussed eastern shallow plume has contributed contaminants to Flint Pond Marsh, and possibly to Flint Pond. Again, this groundwater enters the Marsh as flow under Route 3 and as seepage that enters the highway's drainage system east of the eastern landfill lagoon. This seepage then discharges to the Marsh through a culvert under the highway. The highest concentration of arsenic detected in the Marsh sediments (300 mg/kg) was found near this culvert. The average arsenic concentrations for Marsh sediments was an order of magnitude lower at 30 mg/kg. This plume could continue to introduce contaminants to the Marsh after capping, especially if barrels or other waste containers in the landfill corrode and release their contaminants. However, elimination of the eastern lagoon and leachate seeps as a result of the cap will eliminate a significant input of contaminants to the Marsh. The groundwater draw down as a result of Cannongate's pumping most likely minimized groundwater impacts on the Marsh, but future contributions from rising shallow bedrock groundwater may occur since natural, locally upward gradients have been reestablished.

F. Surface Water

The only organic contamination detected in Dunstable Brook, Bridge Meadow Brook, Flint Pond Marsh or Flint Pond surface water during the remedial investigation were very low levels of xylene in the southwestern drainage swale within 500 feet of the landfill. Aluminum was detected in three locations (Bridge Meadow Brook, Flint Pond, and near the Hoare property) at concentrations less than 1 mg/l, and cyanide was detected in one sample from Flint Pond at 110 ug/l. On site, VOC concentrations in the landfill lagoons were observed to be in the 10^4 ug/l range in 1985, and in the 10^2 ug/l range in 1987.

Sampling done by EPA in May 1988 also found only very low levels of contamination in the southwestern swale immediately downstream from the landfill. Landfill lagoon VOC concentrations, however, were detected in the 10^4 ug/l range in this sampling episode. VOC concentrations in leachate are expected to vary seasonally, with downstream contaminant migration occurring during periods of high runoff. Construction of the landfill cap and the surface water diversion system will eliminate this mechanism of contaminant migration.

As mentioned previously, landfill contaminants can also be transported to surface waters via groundwater discharge, with Dunstable Brook, Flint Pond Marsh and possibly Flint Pond being the principal receptors. Again, enough time has elapsed for contaminants to reach the Marsh and Pond, but not enough to reach Dunstable Brook. Groundwater modeling performed during the RI predicted that once the southwestern plume does discharge to the Brook, contaminant concentrations would be quickly diluted to below detection levels.

VI. Summary of site risks and response objectives

The Endangerment Assessment completed by Alliance in January 1987 described the potential exposure and risks to human health and the environment based on site data collected by NUS through 1985. The baseline risk assessment done as part of the most recent remedial investigation used this information as well as the 1987 data generated during the RI to characterize future on- and off-site risks subsequent to landfill capping.

Thirty-one contaminants of concern, listed in Table 6, were selected for quantitative evaluation in the risk assessment. These contaminants constitute a representative subset of the more then sixty contaminants identified at the site during the RI. The thirty-one contaminants were selected to represent potential on-site and off-site risks based on their toxicity, concentration, prevalence, and persistence in the environment.

Potential human health effects associated with the contaminants of concern as a result of exposure to these contaminants in groundwater, landfill gas emissions, surface water, biota and sediments were estimated quantitatively through the development of several hypothetical exposure scenarios. Incremental lifetime cancer risks and a measure of the potential for noncarcinogenic adverse health effects were estimated for the various exposure scenarios. The exposure scenarios were developed to reflect the potential for exposure to hazardous substances based on the characteristic use and location of the site. The results of the risk assessment are summarized in Table 7. Carcinogenic risks are considered acceptable by EPA if the computed total incremental carcinogenic risk (ICR) for an individual, predicted as a result of possible exposure to contaminants originating from a Superfund site, is below $1x10^{-4}$. The threshold for acceptable non-carcinogenic risks is usually a hazard index between 1 and 10. The Hazard Index is the term used to describe the ratio between an exposure dose (expressed in mg/kg/day) and a relevant contaminant specific non-carcinogenic guideline such as the reference dose. The carcinogenic and non-carcinogenic risks are presented in Table 7 by media and exposure scenario.
Given these results of the risk assessment, guidelines in the Superfund Public Health Evaluation Manual (EPA, 1986) were then used to assist EPA in the development of response objectives. These objectives were developed to mitigate existing and future threats to human health and the environment. These response objectives are:

- Reduce potential future human health risks from ingesting benzene and arsenic in overburden groundwater southwest of the landfill.

- Reduce potential human health risks from benzene, arsenic, bis (2-ethylhexyl) phthalate, and trichloroethene in deep bedrock groundwater east of the landfill, with respect to use as a drinking water supply.

- Remediate shallow eastern groundwater to comply with Safe Drinking Water Act (SDWA) maximum contaminant levels (MCL's) and Resource Conservation and Recovery Act (RCRA) groundwater corrective action requirements (40 CFR §264.92-100).

- Reduce potential human health risks posed by bromoform and various carcinogenic contaminants in landfill vent emissions (primarily, 1,1-dichloroethene, 1,1,2,2-tetrachloroethane, vinyl chloride, methylene chloride, and carbon tetrachloride).
- Reduce potential human health risks from PAHs in sediments west of Dunstable Road in the leachate drainageway to Dunstable Brook, as well as short reaches of Dunstable Brook itself.

Finally, since this cleanup phase includes operable unit four as well as three (see section IV), response objectives include the treatment of leachate collected from the landfill cap's leachate collection system.

As a result of these response objectives, target cleanup levels were developed for the southwestern shallow aquifer, the eastern shallow bedrock and overburden aquifers, the Dunstable Brook sediments, and the landfill vent emissions. These target cleanup levels were developed to protect human health and the environment in the areas of concern, and are based on the results of the risk assessment or on applicable or relevant and appropriate regulatory requirements (ARARs). Table 8 lists the cleanup levels for the respective areas of concern, and also shows whether the cleanup level is risk-based or ARAR-based.

VII. Documentation of Significant Changes

EPA adopted a preferred alternative for remediation of shallow groundwater and leachate, landfill gas, and contaminated sediments at the site in the Proposed Plan issued on July 21, 1988. The preferred alternative for groundwater and leachate was extraction of contaminated southwestern and eastern shallow groundwater plumes, and combined treatment of the extracted groundwater with leachate collected from the cap system. The treatment system included biological treatment and would have discharged to Dunstable Brook. The preferred alternative for the landfill gas was collection and incineration of vent emissions, while for sediments the preferred alternative was excavation, solidification and landfill capping. The preferred alternative also included off-site deep bedrock groundwater and residential well monitoring.

The selected remedies of this ROD are identical to the preferred alternatives of the Proposed Plan, except that the final discharge of treated groundwater and leachate will be to groundwater rather than to Dunstable Brook, if feasible. This is not a significant difference because the groundwater and leachate will be treated by the same technologies and to the same standards as in the Proposed Plan. In fact, groundwater reinjection will offer some natural attenuation to the treated discharge. It was not preferred in the Proposed Plan because an appropriate groundwater reinjection location with sufficient capacity for accepting the discharge had not been identified with absolute certainty. In order to get State approval of a Dunstable Brook discharge, however, a variance to the State's surface water anti-degradation policy would be needed. The variance would require that all other alternatives to a Dunstable Brook discharge be infeasible. Thus further evaluation of a groundwater reinjection discharge is required.

There are deep bedrock wells to the north and southeast of the site that are strong candidates for reinjection wells. During remedial design, these areas and others will be assessed in detail to determine if groundwater reinjection is feasible and appropriate. If it is found to be infeasible or inappropriate, the treated discharge will be to a surface water, either Dunstable Brook, Bridge Meadow Brook or the Merrimack River, approved by both the State and EPA. Again, a variance from the State's surface water anti-degradation policy would be needed for approval of a discharge to either of the brooks. Appropriate surface water discharge requirements will be developed if it is determined necessary to discharge to surface water rather than groundwater.

VIII. Development and screening of response alternatives

A. Statutory requirements

Prior to the passage of the Superfund Amendments and Reauthorization Act of 1986 (SARA), actions taken in response to releases of hazardous substances were conducted in accordance with CERCLA as enacted in 1980 and the revised National Oil and Hazardous Substances Pollution Contingency Plan (NCP), 40 CFR Part 300, dated November 20, 1985. Until the NCP is revised to reflect SARA, the procedures and standards for responding to releases of hazardous substances, pollutants and contaminants shall be in accordance with Section 121 of CERCLA and to the maximum extent practicable, the current NCP.

Under its legal authorities, EPA's primary responsibility at Superfund sites is to undertake remedial actions that are protective of human health and the environment. In addition, Section 121 of CERCLA establishes several other statutory requirements and preferences, including: a requirement that EPA's remedial action, when complete, must comply with applicable or relevant and appropriate environmental standards (ARARs) established under federal and state environmental laws unless a statutory waiver is granted; a requirement that EPA select a remedial action that is cost-effective and that utilizes permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable; and a statutory preference for remedies that permanently and significantly reduce the volume, toxicity or mobility of hazardous wastes over remedies that do not achieve such results through treatment. Response alternatives were developed to be consistent with these Congressional mandates.

B. Technology and alternative development and screening

CERCLA, the NCP, and EPA guidance documents (including "Guidance on Feasibility Studies Under CERCLA" dated June 1985, and the "Interim Guidance on Superfund Selection of Remedy", EPA Office of Solid Waste and Emergency Response, Directive No. 9355.0-19 dated December 24, 1986) set forth the process by which remedial actions are evaluated and selected. In accordance with these requirements and guidance documents, treatment alternatives were developed for the site ranging from alternatives that, to the degree possible, would eliminate the need for long-term management (including monitoring) at the site to alternatives involving treatment that would reduce the mobility, toxicity, or volume of the hazardous substances as their principal element. In addition to the range of treatment alternatives, no-action and, when possible, containment alternatives were developed for each affected media in accordance with Section 121 of CERCLA.

Section 121(b)(1) of CERCLA presents several factors that, at a minimum, EPA is required to consider in its assessment of alternatives. In addition to these factors and the other statutory directives of Section 121, the evaluation and selection process was guided by the EPA document "Additional Interim Guidance for FY '87 Records of Decision" dated July 24, 1987. This document provides direction on the consideration of SARA cleanup standards and sets forth nine factors that EPA should consider in its evaluation and selection of remedial actions. The nine factors are:

1. Compliance with applicable or relevant and appropriate requirements (ARARs);
2. Long-term effectiveness and permanence;
3. Reduction of toxicity, mobility or volume;
4. Short-term effectiveness;
5. Implementability;
6. Community acceptance;
7. State acceptance;
8. Cost; and
9. Overall protection of human health and the environment.

Chapters four, five, and six of the FS identified, assessed and screened response technologies based on effectiveness and implementability. The effectiveness assessment considered the degree to which technologies achieved cleanup target levels and complied with applicable or relevant and appropriate requirements (ARARs). The implementability assessment considered the technical feasibility, demonstrated performance, and availability of major component pieces of each technology identified. This initial screening was performed on groundwater and leachate alternatives, sediment alternatives, and landfill gas alternatives. Its purpose was to narrow the number of potential remedial actions for further detailed analysis while preserving a range of options. Remedial alternatives for groundwater and leachate, sediment, leachate only, and landfill gas were then evaluated in detail in chapters 7,8,9 and 10 of the FS, respectively, based on effectiveness, implementability and cost. Leachate remedies were analyzed both with groundwater and separately in the event that the "no-action" groundwater alternative were to be selected for operable unit three. In summary, of the nineteen alternatives originally developed in Chapter 5, sixteen were retained for detailed analysis. Table 9 lists the technologies originally identified in Chapter 4; and identifies the alternatives that were subsequently eliminated in Chapter 4; the alternatives that were eliminated in Chapter 6's initial screening; and the alternatives that were retained for detailed analysis.

IX. Description and summary of the detailed analysis of alternatives

This section presents a narrative summary of each alternative evaluated in the detailed analyses chapters of the FS. A tabular assessment of each alternative based on the previously mentioned nine criteria is presented in Table 10. Both the narrative summary and Table 10 are arranged by media.

A. Leachate and groundwater alternatives

1. No action (GW-1)

The "no-action" alternative provides a baseline against which other alternatives can be compared. Landfill leachate would be treated separately if the no-action alternative were selected for groundwater. The no-action alternative would include a groundwater monitoring program in which samples would be collected and analyzed four times a year. Because contaminants would continue to migrate from the site in this alternative, EPA would review site conditions every five years to determine whether additional remedial actions were necessary to protect human health and the environment. This alternative requires no treatment technology and thus could be readily implemented. However, it would not be effective in protecting human health and the environment, would not reduce the toxicity, mobility, or volume of the site contaminants, and, as explained in Table 10-Criterion 7, would not comply with SDWA and RCRA ARARs. The present worth costs listed below, and those for the remaining leachate and groundwater alternatives, are based on ten percent interest and thirty years of operation.

Estimated Time for Construction and Operation: 30 Years
Estimated Capital Cost: $151,000
Estimated Annual Operation and Maintenance Cost: $113,000
Estimated Present Worth: $1,216,000

2. Extraction, carbon adsorption, and discharge (GW-2)

This alternative would entail extraction of shallow groundwater to the east and southwest of the site, as well as deep bedrock groundwater to the east of the site. Leachate from the landfill cap system would be combined with the extracted groundwater and treated on site to remove metals and organic compounds. For this alternative, the treatment process would include hydroxide precipitation, carbon adsorption, and, if necessary, ion-exchange. Treated groundwater and leachate would be discharged via pipeline to Dunstable Brook or the Merrimack River, or reinjected into groundwater. As discussed briefly in section IV and in more detail in sections X and XI, the selected discharge option is groundwater reinjection, if feasible. However, since the feasibility and costs of a groundwater discharge will be developed during remedial design, the costs presented below and for the next two alternatives are based on discharge to Dunstable Brook. The relative difference in costs for these alternatives will be the same, though, since discharge costs, regardless of the discharge location, will be the same for each alternative.

This alternative would protect human health and the environment by reducing risks of exposure to contaminated groundwater, and would permanently and significantly reduce the volume, mobility, and toxicity of the groundwater contaminants. The extraction of contaminated groundwater would attain SDWA and RCRA ARARs, and the treated discharge would meet Clean Water Act (CWA) discharge requirements as required by the National Pollutant Discharge Elimination System (NPDES). The treatment technologies used in this alternative are well proven, reliable, and would be easy to implement. Construction of a discharge pipeline, however, would cause some negative environmental impacts due to temporary disruption of wildlife habitats. Moreover, acetone, 2-butanone and benzoic acid, three aqueous contaminants of concern expected at significant concentrations, would not be as amenable to removal with this alternative as compared to the selected remedy.

Estimated time for Design and Construction: 2 1/2 years.
Estimated Time for Operation: 5 - 55 years
Estimated Capital Cost: $2,995,000
Estimated Annual Operation and Maintenance Cost $ 686,000

Estimated Total Present Worth Cost: $9,809,000

3. Extraction, air stripping, carbon adsorption and discharge (GW-3)

This alternative is similar to Alternative 2 above, except that air stripping would be added to the treatment process. Approximately one-half the amount of activated carbon would be needed as a result. This alternative would permanently reduce the mobility, toxicity, and volume of contaminants; would meet SDWA, RCRA, and CWA ARARs as well as state allowable atmospheric ambient levels (AAL's); and would provide long-term protection of public health and the environment. This alternative could be readily implemented, although construction of a discharge outfall would pose some temporary negative environmental impacts. This alternative poses potential risks to human health throughout its implementation due to emissions of vapor phase VOCs from the air stripping process. These emissions could conceivably be tied into a landfill gas treatment system, however. As with Alternative 2, this alternative could present problems in removing acetone, 2-butanone and benzoic acid.

Estimated Time for Design and Construction: 2 1/2 years
Estimated Time for Construction and Operation: 5-55 years
Estimated Capital Cost: $2,893,000
Estimated Annual Operation and Maintenance Cost: $695,000
Estimated Total Present Worth Cost: $9,792,000

4. Extraction, biological treatment, carbon adsorption and discharge (GW-5)

This alternative is also similar to Alternative 2 above, except that biological treatment would be added as the first step of the treatment process. Estimated activated carbon usage would be reduced to approximately four pounds per day (ppd) compared to 100 ppd and 50 ppd for Alternatives 2 and 3, respectively. As with these other alternatives, some negative environmental impacts would result due to the temporary disruption of wildlife habitats during construction of a discharge outfall. Treatment residuals would be increased by approximately fifteen percent, by weight, as compared to alternatives 2 and 3, but otherwise this alternative could be readily implemented. It would permanently reduce the mobility, toxicity, and volume of contaminants; would meet RCRA, SDWA and CWA ARARs; and would provide long-term protection of public health and the environment. In contrast to Alternatives 2 and 3, this alternative should readily remove acetone, 2-butanone and benzoic acid. For reasons explained in section XI, the treatment technology of this alternative is the selected remedy's technology for the treatment of groundwater and leachate. The selected remedy differs somewhat from this alternative, however, since it: a) requires groundwater monitoring rather than extraction and treatment for the eastern deep bedrock plume; and b) selects final discharge to groundwater rather than Dunstable Brook, if feasible.

Estimated Time for Design and Construction: 2 1/2 years
Estimated Time for Operation: 5-55 years
Estimated Capital Cost: $3,318,000
Estimated Annual Operation and Maintenance Cost: $593,00
Estimated Total Present Worth Cost: $8,800,000

5. Extraction, off-site treatment, and discharge (GW-6)

For this alternative, extracted groundwater and leachate would be piped to on-site storage tanks and then transported off site to an EPA-permitted hazardous waste facility using tanker trucks. This alternative would provide long-term protection of public health and the environment, and would comply with SDWA and RCRA ARARs. This alternative is technically feasible, but it would require long-term contracts with licensed firms to transport and treat the wastes. These contracts and thus the reliability of this alternative could be jeopardized by potential noncompliance of the off-site treatment facility. Some health risks to workers would be posed by transportation of the contaminated groundwater and leachate, and truck traffic to and from the site would continue through the entire period of implementation. Costs for this alternative are at least one order of magnitude higher than costs for the other groundwater and leachate alternatives.

Estimated Time for Design and Construction: 1 1/2 years
Estimated Time for Construction and Operation: 5-55 years
Estimated Capital Cost: $1,861,000
Estimated Annual Operation and Maintenance Cost: $12,256,000
Estimated Total Present Worth Cost: $ 117,397,000

B. Landfill gas alternatives

1. No action (GAS-1)

In this alternative, landfill gas would be discharged directly to the atmosphere without treatment. Since the gases would be emitted from the landfill vents that will be constructed as part of the landfill cap, there would be no immediate cost associated with this alternative. Significant on-site risks to human health and the environment would remain unmitigated. This alternative would most likely not attain Massachusetts' allowable ambient levels (AAL's), and would not reduce the toxicity, mobility, or volume of contaminants. As required by SARA, EPA would review this alternative every five years to determine whether remedial action is necessary.

2. Gas flaring (GAS-3)

In this alternative, gas emissions from the landfill vents would be collected and treated with gas scrubbers to remove acidic compounds and then piped to an on-site gas flaring unit. The flaring unit would burn the landfill gas directly and, after initial startup, would be fueled by methane contained in the landfill gas emissions.

Flaring technology has been used to burn conventional landfill gas but is not as well demonstrated for mixed waste sites. Pilot-scale tests would be required to determine the efficiency of the system in destroying the specific compounds present at the Charles George site. This alternative and the following two alternatives would produce secondary air pollutants from the combustion process, but these would contain significantly less contaminants then the current level of emissions. Nevertheless, scrubbing or similar air treatment technology would be installed after flaring if air monitoring demonstrates non-compliance with Clean Air Act (CAA) national secondary ambient air quality standards (NAAQS). Thus CAA ARARs would be attained. Also, gaseous landfill contaminants should be well below state AAL's upon transport to off-site residential areas. Risks due to inhalation of landfill gas and nuisance odors would be reduced, but EPA's on-site risk-based target cleanup levels may not be attained. Also, the wastewater sidestream from the pre-flaring scrubber would require treatment throughout the operation of the flare. The present worth costs listed below and those for the remaining landfill gas alternatives include design, construction and operating costs, and are based on ten percent interest and thirty years of operation. Since design costs are included, the total present worth cost for each alternative will be different than as listed in the FS.

Estimated Time for Design and Construction: 13 months
Estimated Time for Operation: 20-30 years
Estimated Capital Cost: $237,000
Estimated Annual Operation and Maintenance Cost: $37,000
Estimated Total Present Worth Cost: $586,000

3. Incineration (GAS-4)

In this alternative, gas emissions from the twenty-eight (28) future landfill vents would be collected and incinerated on site. Complete combustion within the incinerator would be sustained by blowing 3000-5000 cubic feet per minute (cfm) of air into it. No pretreatment would be required, but auxiliary fuel would initially be necessary to fire the incinerator to operating temperatures above 1,200°F. Thereafter, methane in the landfill emissions would fuel the combustion. The incinerator would discharge directly to the atmosphere, unless scrubbing or other air treatment technologies are demonstrated to be required.

Incineration is a proven technology for treating gaseous streams containing both conventional landfill gases and hazardous compounds. Some secondary air pollutants would be generated by the combustion process. However, incinerators have demonstrated VOC removal rates above ninety-nine percent, and attainment of such efficiencies would achieve all the target vent emission cleanup levels. Nuisance odors would be minimized, and off-site gaseous VOC levels from the landfill should be below AAL's. Thus incineration would protect human health and the environment in both the short and long term, and would provide a permanent reduction in air-borne site contamination. For reasons explained in section XI, incineration is the selected remedy for the management of landfill gas emissions.

Estimated Time for Design and Construction: 16 months
Estimated Time for Operation: 20-30 years
Estimated Capital Cost: $685,000
Estimated Annual Operation and Maintenance Cost: $8,000
Estimated Total Present Worth Cost: $1,034,000

4. Combustion/Medium Btu gas recovery (GAS-5)

In this alternative, approximately twenty-four deep gas wells would be installed within the landfill boundaries to extract the gases generated by the landfill. Gas from these wells and from the landfill vents would be passed through a scrubber to remove acidic gases, and then burned in an internal combustion engine to generate electricity. Exhaust gases from the combustion process would be discharged directly to the atmosphere, unless scrubbing or other air treatment technologies are demonstrated to be required.

This alternative's technology has been proven for burning municipal landfill gases, but not for sufficiently treating hazardous substances. This technology could also be more prone to corrosion failure and down time compared to flaring and incineration. As with these other gas treatment alternatives, some secondary air pollutants would be generated. This alternative would provide some protection of human health and the environment, but it would not be as protective as gas flaring or incineration. Based on estimated removal rates, EPA's target cleanup levels would not be achieved for over half of the contaminants of concern.

Drilling of the deep gas wells would initially contribute to air quality problems, and could delay completion of the landfill cap. Seams between the deep gas wells and the synthetic landfill cap could increase the potential for leakage through the cap, and post closure operation and maintenance costs could be increased.
Estimated Time for Design and Construction: 17 months
Estimated Time for Operation: 20-30 years
Estimated Capital Cost: $1,658,800
Estimated Annual Operation and Maintenance Cost:
$90,000 in revenue per year

Estimated Total Present Worth Cost: $809,000

C. Sediment alternatives

1. No action (SED-1)

In the no action alternative, contaminated sediments would remain in place and untreated in Dunstable Brook. As required by SARA, EPA would review site conditions every five years to determine whether remedial action is necessary. Public health risks expected to be significantly above a $1x10^{-6}$ incremental cancer risk in the most probable exposure scenario would remain unmitigated, and there would be no reduction in the toxicity, mobility or volume of contaminated sediments. There are no costs associated with this alternative.

2. In-site capping (SED-2)

This alternative would cover contaminated sediments located in the Dunstable Brook tributary immediately west of the landfill and in portions of Dunstable Brook. The cover would consist of a synthetic fabric filter placed directly over the contaminated sediments and a four-to-six inch layer of crushed stone placed on top of the fabric layer. This alternative is technically feasible and would reduce the mobility of PAH contaminants. This alternative would protect human health by preventing direct contact with contaminated sediments. It would protect the environment to the extent that sediments would be prevented from moving downstream from the capped area, but it would not prevent contaminants from entering groundwater. In addition, installation of the cap would cause adverse impacts to aquatic and terrestrial habitats. Since the following sediment alternatives offer less impacts to these habitats, this alternative would not comply with CWA § 404 ARARs.

Estimated Time for Design and Construction: 6 months
Estimated Period of Operation: 30 year lifetime of cover materials
Estimated Capital Cost: $ 98,300
Estimated Annual Operation and Maintenance Cost: $ 4,900
Estimated Total Present Worth Cost: $ 144,200

3. Excavation and on-site disposal (SED-7)

This alternative and the remaining sediment alternatives would entail excavating approximately 500 cubic yards (cy) of contaminated sediments in Dunstable Brook and the tributary from the western pump station down to a depth of approximately one foot. Excavation machinery on land would be used as explained in Chapter 8 of the FS. In this alternative, the excavated sediments would then be placed on the landfill prior to construction of the landfill cap. Completion of the cap over the sediments would reduce further contaminant migration.

Implementation of this alternative and the remaining alternatives would pose some short-term environmental risks due to the excavation process. Oil booms and silt screens would thus be used during dredging to minimize PAH migration downstream due to sediment resuspension. The impacted areas would also be restored to their original condition. Thus this alternative would meet CWA and Executive Order 11990 (EO 11990) ARARs (see section XII.B), and would provide long-term protection of human health and the environment. However, construction requirements for fill material to be used during capping may not be attained.
Estimated Time for Construction and Operation: 3-6 months
Estimated Total Cost: $40,800

4. Excavation, solidification and on-site disposal (SED-3)

This alternative is similar to the previous alternative except that the excavated sediments would be solidified on site before being placed on the landfill for capping. Solidification entails mixing the sediments with standard setting agents and silicate-based additives to produce a granular soil-like material of low solubility. Some bench-scale testing of additives would be necessary to determine if any are effective in immobilizing PAH's. Solidifying and capping the sediments could minimize PAH migration more so than capping only, and the solidified sediments would attain construction requirements for fill material. This alternative meets ARARs and would provide long-term protection of human health and the environment.

Estimated Time for Design and construction: 3-6 months
Estimated Total Cost: $79,000

5. Excavation, thermal aeration, and on-site disposal (SED-4)

This alternative is similar to the previous alternative, except that the sediments would be treated by thermal aeration rather than by solidification. Hot air would be forced through the sediments to cause PAHs and other organic compounds to volatilize. The contaminated air would be passed through an air pollution control system to remove the contaminants before being released to the atmosphere. The treated sediments would then be disposed on site prior to landfill capping.

Thermal aeration has been demonstrated, on a pilot scale, to be effective in removing PAHs. This alternative would reduce the toxicity, mobility, and volume of contaminated sediments more so than the previous sediment alternatives. On-site thermal aeration would meet CWA, EO 11990 and CAA ARARs, and would provide long-term protection of public health and the environment. This alternative would cost significantly more than all the other sediment alternatives, except off-site incineration (SED-6).

Estimated Time for Construction and Operation: 3 to 6 months
Estimated Total Cost: $915,000

6. Excavation, off-site solidification and disposal (SED-5)

In this alternative, contaminated sediments would be excavated and placed in drums. The drummed sediments would be transported by a licensed hazardous waste hauler to an EPA-permitted hazardous waste treatment facility for solidification and disposal. This alternative could be readily implemented, would meet RCRA, CWA and EO 11990 ARARs, and it would provide long-term protection of human health and the environment by removing contaminated sediments from the site vicinity. By solidifying the sediments at the off-site disposal location, the mobility of the contaminants would be reduced. Some short-term environmental and human health risks would be associated with excavation and transportation of the contaminated sediments. This is the third most expensive sediment alternative, and it would not respect CERCLA's statutory preference for on-site treatment.

Estimated Time for Construction and Operation: 6 months
Estimated Total Cost: $208,500

7. Excavation, incineration, and off-site disposal (SED-6)

In this alternative, contaminated sediments would be excavated and transported to an EPA-permitted hazardous waste facility for incineration. Incineration would destroy organic compounds by burning the sediment at a temperature up to 2,400°F, depending on the type of incinerator used. The exhaust gases from the incinerator would be passed through air pollution control devices to remove particulate matter and acidic gases before being released to the atmosphere. Incineration has been demonstrated to be a reliable method of destroying organic compounds. This alternative would meet RCRA, CWA, EO 11990 and CAA ARARs, would permanently reduce the toxicity, mobility, and volume of the sediment contaminants, and would protect human health and the environment. Some short-term environmental and human health risks would be associated with the excavation and transportation of the contaminated sediments. This is the most expensive sediment remedy, and it would not respect CERCLA's statutory preference for on-site treatment.
Estimated Time for Construction and Operation: 3 to 6 months
Estimated Total Cost: $1,404,800

X. The selected remedy

The following selected remedy for the management of contaminant migration and treatment of leachate represents the remaining anticipated cleanup measures necessary for the Charles George Landfill. Combined with the water supply and source control (landfill capping) remedial actions, implementation of the phase III remedy will effect a comprehensive response to the release of contaminants at the site. The selected remedy for groundwater, leachate, gaseous vent emissions, and off-site sediments is detailed below.

A. Groundwater and leachate remedy

Leachate collected on-site as part of the landfill cap system will be combined with contaminated overburden and shallow bedrock groundwater and treated on-site with biological treatment, metals precipitation, carbon adsorption and, if necessary, ion exchange treatment units. The treated leachate and groundwater will be monitored and discharged into groundwater on site, if feasible. If not, the discharge will be to a nearby approved surface water.

An upgradient groundwater diversion trench will also be installed to assist in lowering the water table beneath the landfill, thereby minimizing direct contact between groundwater and landfill wastes. In addition, groundwater monitoring will be performed to provide early warning of possible increases in contaminant concentrations that may impact residential drinking wells.

As discussed earlier in Section IV, some interim leachate management should be necessary since collection of leachate as part of the source control remedy will most likely begin before implementation of this groundwater and leachate treatment remedy. As recommended in the Feasibility Study on Treatment of Leachate from Charles George Landfill (CDM, 1986), this interim leachate will be transported off-site for treatment at an EPA-permitted hazardous waste treatment facility. This alternative is the most practicable and protective solution given the time constraints involved. Other alternatives developed during construction of the landfill cap, such as leachate holding lagoons, will be considered, however. In any event, construction measures should be taken during installation of the landfill cap leachate collection system to minimize the construction-phase collection of water runoff and precipitation infiltration.

The details of the extraction systems and diversion trench will be finalized during the design phase of the remedy. The upgradient diversion trench should be carefully designed so that the trench will intercept clean overburden groundwater only. If the trench is installed too deep, it may draw contaminated groundwater from the landfill. Based on existing geologic and hydrogeologic data, the trench should be: a) approximately 700 feet long; b) located 250 to 350 north of the landfill (see Figure 7-2 in the FS); and c) installed with a bottom elevation greater than 204 feet mean sea level. The eastern contaminated groundwater extraction system should, if possible, have the capability to independently withdraw overburden and shallow bedrock groundwater, since the eastern overburden aquifer could possibly attain cleanup levels before the eastern shallow bedrock aquifer. For the southwestern extraction system, more monitoring of shallow bedrock groundwater will be done to verify that this hydrologic unit does not warrant remediation. If this monitoring indicates unacceptable risks (as defined in Section VI) from carcinogenic or noncarcinogenic contaminants, however, the southwestern extraction system will be designed to remediate shallow bedrock groundwater as well as overburden groundwater.

The extracted groundwater will be combined with leachate collected as part of the cap system, and will be treated on-site to attain the discharge levels listed in Table 11. Bench-scale or pilot-scale testing of the selected treatment system using representative leachate and groundwater samples should be performed during remedial design to ensure that all the unit processes are necessary, and that the discharge levels are achieved in a cost-effective manner. This testing could demonstrate that replacement or rearrangement of unit processes, or that separate treatment schemes for leachate and groundwater, are more cost-effective in meeting discharge requirements. The final design will take these results into consideration, thus the treatment system could conceivably be different than as outlined on page 26.

After effluent monitoring to determine compliance with discharge requirements, the treated groundwater and leachate will be discharged into groundwater on site, if feasible. More hydrogeological investigation will be performed during remedial design to determine if a groundwater discharge is appropriate and feasible. If groundwater discharge is found to be inappropriate or infeasible, the treated groundwater and leachate will be discharged to a surface water approved by the Commonwealth and EPA. If a surface water discharge is needed, appropriate discharge levels will be developed during remedial design for approval by the Commonwealth and EPA. The clean diverted upgradient groundwater will be discharged as appropriate.

Side streams generated from the treatment process will require treatment or disposal. Spent activated carbon from the carbon adsorption process and spent regeneration solution and resin beds from the ion exchange process, if used, can be transported off-site for reprocessing or disposal by equipment vendors. Waste activated sludge from the biological treatment process and hydroxide sludge from the precipitation process, if used, will be dewatered onsite and properly disposed as a hazardous waste according to Subtitle C of the Resource Recovery and Conservation Act (RCRA). During remedial design, the feasibility of constructing an extension to the CGL for the disposal of these sludges will be evaluated. If it is determined that a secure extension to the landfill, complete with the minimum technology requirements of 40 CFR § 264.301, is not feasible or cost-effective, than these sludges will be disposed of in an off-site Subtitle C landfill.

The groundwater monitoring to be performed as part of this remedy will be in addition to the post-closure groundwater monitoring required by EPA's second ROD. The post-closure monitoring will focus on groundwater surrounding the landfill to assess effects of the landfill cap, whereas the Phase III groundwater monitoring will focus on detecting potential but unexpected contamination in both groundwater monitoring wells and residential drinking wells further off site. As the second ROD mentions, however, implementation of the off-site groundwater monitoring can be incorporated into the post-closure groundwater monitoring plan.

The details of the off-site groundwater monitoring will be developed during remedial design. A list of approximately forty-five off-site wells to be monitored once per year will be generated. A representative subset of these wells will be sampled quarterly for a minimum of 5 years in order to estimate seasonal variations in contaminant concentrations. The well list should focus on bedrock wells in the area, including wells 9, 11, 12, 27, 29, 53, 56, 57, 58, 59, 63, 66, 67, 70, 72, 84 and 88 as defined in Table B-15 of volume II of the RI, as well as shallow wells in the Dunstable/Red Gate Road Area, the Dunstable Road/Blodgett Street area, and the Flint Pond area. Wells not on the list but in the defined area and in similar groundwater zones can be substituted into the monitoring program if needed. Future remedial actions including extensions to the new waterline will be considered if the monitoring program determines that landfill contaminants could pose unacceptable risks to human health via residential drinking wells.

Implementation of institutional controls to prevent future use of the contaminated deep bedrock aquifer, especially large yield pumping, would increase the protectiveness of the remedy. EPA will work with State and local officials to assist in determining appropriate controls and in evaluating potential impacts from development proposals involving large yield pumping.

B. Vent emission remedy

Landfill vent emissions from the twenty-eight landfill vents to be constructed as part of the landfill cap will be collected and incinerated on-site in a fume incinerator. During initial startup, auxiliary fuel will heat the incinerator to oxidation temperatures above 1,200° F. This temperature will be sustained by using methane in the emissions as fuel. Landfill gas constituents will be oxidized in the incinerator's central chamber. To prevent leaks to the atmosphere, an exhaust fan downstream of the incinerator will act as vacuum prior to oxidation. Condensation/acid-scrubbing will not be required prior to incineration, and the fan design and operation will allow proper retention time for contaminant combustion in the central chamber.

Incineration of vent emissions will continue for as long as necessary to mitigate health risks.

Remedial design of the gas emission remedy should start with the design of the gas collection system. This will allow for cost and time savings if construction of the manifold system can be incorporated into the upcoming construction of the landfill cap and gas venting system. Also, the design of the collection and incineration system should provide for mitigating measures such as modular incinerator units or maximized atmospheric dilution in the event the primary incinerator experiences down time. The design should also provide for gas sampling throughout the collection system and at the stack.

Combustion parameters such as temperature, carbon monoxide, carbon dioxide, oxygen and total hydrocarbon concentrations will be continuously monitored to provide an indication of the contaminant destruction efficiency of the incinerator. As defined in Section XI.B.2, periodic monitoring of the VOC contaminants of concern will be performed to confirm attainment of EPA's on-site, risk-based target cleanup levels. Operating conditions will be based on the continually monitored combustion parameters which match with acceptable VOC monitoring results.

On-site air monitoring will also be performed downwind of the incinerator stack, within the stack plume, to assess compliance with national secondary ambient air quality standards (NAAQS) and State AAL's. The frequency of sampling will be the same as that defined for VOC stack sampling in section XI.B.2. Parameters to be included are sulfur dioxide, carbon monoxide, nitrogen dioxide, and the target vapor phase VOC's. If this sampling demonstrates non-compliance with the NAAQS, scrubbing or other appropriate air treatment technologies will be promptly installed at the incinerator so that compliance is attained.

C. Sediment remedy

Contaminated sediments in the Dunstable Brook tributary leading from the landfill's existing western leachate pump station, and possibly some downstream reaches of the Brook itself, will be dredged down to about one foot in depth, transported to the site for solidification, then placed on the uncapped landfill for capping with the source control's high density polyethylene (HDPE) liner. This sediment remedy requires some coordination with the cap construction, but enough time is anticipated to allow for implementation of this alternative before installation of the HDPE liner. If needed, other alternatives which offer equal permanence and protectiveness, and which meet construction fill requirements, will be considered.

Remedial design will start with sediment sampling to determine the present extent of PAH contamination above EPA's risk-based cleanup level of 1 mg/kg. Once this sampling defines the cleanup area, construction of a small, temporary gravel road following the brook can be completed as needed for excavation. Once the excavation work is complete, the wetland area impacted will be restored to its original condition. The excavation, solidification and placement of the contaminated sediments will then proceed according to Sections 8.1 and 8.4 of the FS. Bench-or pilot-scale tests will be done to determine appropriate use of PAH-immobilizing additives.

XI. Rationale for selection and points of compliance

The rationale for choosing the selected alternatives is based on the assessment of each criteria listed in section VIII of this document. In accordance with Section 121 of CERCLA, to be considered as a candidate for selection in the ROD, the alternative must have been found to be protective of human health and the environment, and able to attain ARARs unless a waiver is warranted. In assessing the alternatives that met these threshold statutory requirements, EPA focused on the other evaluation criteria, including, short term effectiveness, long term effectiveness, implementability, reduction of mobility, toxicity and volume, and cost.

EPA also considered nontechnical factors that affect the implementability of a remedy, such as state and community acceptance. Thus, the nine factors which were discussed in section VIII, were evaluated during the decision process. Again, these nine factors are compared for each alternative in Table 10. Based upon this comparative analysis and taking into account the statutory preferences of CERCLA, EPA selected the remedial approach for the Site.

A. Groundwater and leachate

1. Rationale

Extraction and treatment of southwestern overburden is necessary to reduce the unacceptable risks to human health and the environment posed by this plume, as discussed in section VI, and to comply with groundwater-quality ARAR's of SDWA and RCRA. Southwestern shallow bedrock may also require remediation, as described in section X.A, depending on the remedial design monitoring results from this hydrologic unit. Extraction and treatment of eastern overburden and shallow bedrock groundwater is required for compliance with SDWA and RCRA MCL's. Remediation of these eastern upper aquifers will also eliminate their environmental threat to Flint Pond Marsh and Flint Pond.

Contaminated deep bedrock groundwater was not selected for remediation other than continued monitoring for five reasons. The first reason involves impracticability. Given the uncertainties in the spatial extent of the deep bedrock plume and the difficulty in predicting groundwater flow in bedrock, it is considered infeasible to extract the entire deep bedrock plume. Heavy pumping of the eastern deep aquifer could cause further contaminant migration by drawing contamination from the shallow aquifers into deep bedrock. Second, upon activation of the new municipal waterline serving the Cannongate area, scheduled for the fall of 1988, the deep aquifer in the Cannongate area will not be used for drinking water. Third, since the landfill is not expected to contribute more contaminants to the deep plume, MCL's and acceptable risk levels should be attained through natural attenuation at an approximate distance of 1000 east of the landfill/Cannongate axis. This area is comprised mainly of highway and marsh, and is therefore undevelopable. Fourth, this deep plume is not expected to recharge Flint Pond Marsh, Flint Pond or the Flint Pond overburden aquifer. As such, it will not pose environmental risks to these surface waters nor human health risks to users of the Flint Pond overburden aquifer. Finally, a groundwater monitoring program will be implemented to provide early detection of contaminant increases from the deep bedrock plume. Additional remedies will be considered, including extensions to the new waterline, if this monitoring indicates potential significant risks to human health from this plume.

Leachate requires treatment as defined by EPA's remedial operable unit four for the site. Since contaminated groundwater will be extracted for treatment, collected leachate can be combined with groundwater for joint treatment. The biological-based treatment alternative was selected rather than the carbon-based or air-stripping-based alternative for treatment of the combined groundwater and leachate because it should be more effective in removing all the waste stream contaminants, especially acetone, 2-butanone and benzoic acid. The cost estimates for the three combined groundwater and leachate on-site treatment alternatives were roughly equivalent given the accuracy of the estimate, and they were all significantly less costly than off-site treatment (GW-6). As explained in section VII, final discharge to groundwater was selected, if feasible, to comply with Massachusetts' surface water anti-degradation requirements.

2. Points of compliance

The cleanup levels required for the protection of human health and compliance with ARARs are listed in Table 8 for the aquifers to be remediated. These aquifers must be extracted for treatment until these cleanup levels are attained throughout the respective aquifer from the upgradient landfill boundary to the extraction points. As discussed on page 7-11 of the FS, this will result in the attainment of SDWA and RCRA MCL's throughout these aquifers since any downgradient contaminants not extracted will be quickly attenuated to concentrations below respective MCL's. Sampling throughout these aquifers will be continued through remedial design and implementation to monitor compliance with these cleanup levels, and to also monitor other contaminants as listed in Table 11. Once the cleanup levels are attained, a demonstration of consistent attainment will be made by monthly monitoring of the Table 8 contaminants until the cleanup levels have been complied with for twelve consecutive months. If during this demonstration cleanup levels are exceeded, then extraction and treatment of the plume(s) with exceedances will again be required. Once this consistent attainment is demonstrated, the post-closure groundwater monitoring as discussed in section X will be used to monitor subsequent compliance with the cleanup levels.

The concentration levels required for groundwater discharge after treatment are listed in Table 11. These levels shall be attained at a representative sampling location prior to any mixing with the diverted upgradient groundwater. If groundwater and leachate are treated separately, both shall meet these discharge levels prior to mixing.

The diverted upgradient groundwater shall be monitored monthly, before mixing, for the compounds listed in Table 11 during its first year of operation. Appropriate engineering responses will be promptly implemented if contamination is detected. During start up of the treatment plant, weekly monitoring of the Table 11 parameters will be required until compliance with the discharge levels is demonstrated for four consecutive weeks. Monthly monitoring will be required thereafter. If non-compliance is detected, prompt and appropriate engineering responses will be implemented, and weekly monitoring will again be required until compliance is attained for four consecutive weeks.

B. Vent emissions

1. Rationale

The treatment of vent emissions is necessary to reduce unacceptable on-site health risks posed by various gaseous VOC's as discussed in section VI. Risks to human welfare as a result of the objectionable odor, and potential off-site risks to human health given a worst case exposure scenario were also considered in the decision for treatment. Incineration was chosen as the treatment technology because it has been demonstrated as the most effective in achieving the VOC removal efficiencies required. Also, unlike the gas flaring or gas recovery alternatives, incineration will not generate sidestreams requiring treatment. Incineration offers the least amount of adverse, short term impacts, and is the most protective of the gas treatment alternatives.

2. Points of compliance

The cleanup levels required for vent emissions are listed in Table 8. These levels shall be attained at a representative location in the stack. During initial start-up of the incinerator, sampling of the VOC's listed in Table 8 will be performed until all the target levels are attained during four consecutive sampling episodes. Thereafter, the continually monitored parameters described in section X.B will be used to indicate compliance with the target levels. During steady-state operation of the incinerator, the VOC's listed in Table 8 will be analyzed at least annually to monitor long term compliance with the target levels. Appropriate and prompt engineering responses will be implemehted if non-compliance is detected, and demonstration of a return to compliance will be made.

C. Sediment

1. Rationale

Remediation of contaminated sediments in the Dunstable Brook tributary from the existing western pump station, and possibly reaches of the Brook itself, is necessary to reduce to acceptable levels the existing incremental cancer risks above $1x10^{-6}$ for a most probable exposure scenario. As discussed in footnote 5 of Table 7, these risks are expected to be much higher than this in the pump station tributary.

Solidification and on-site disposal was selected as the treatment system because it will cost-effectively minimize PAH migration, and it will be a cost-effective permanent remedy for the contaminated sediments. It will also comply with construction requirements for fill material.

2. Point of compliance

The horizontal extent to which Dunstable Brook sediments will be dredged for treatment will be determined by remedial design sediment sampling. Sediments in the western pump station tributary or the Brook containing carcinogenic PAH concentrations above 1 mg/kg will be excavated, solidified and placed on the landfill for capping.

XII. Statutory Determinations

The phase III remedial actions selected for implementation at the Charles George Landfill are consistent with CERCLA and, to the extent practicable, the NCP. The selected remedies are protective of human health and the environment, and, with the exception of attaining SDWA MCLs in the residual eastern deep bedrock plume, attain ARARs. The selected remedies also offer the best combination of effectiveness, implementability, and cost in comparison with the other protective alternatives. The selected remedies are consistent with section 121 of CERCLA and satisfy the statutory preference for permanent solutions and for treatment which reduces the mobility, toxicity or volume as a principal element. Additionally, the selected remedies utilize permanent solutions and innovative technology to the maximum extent practicable.

A. The selected remedy is protective of human health and the environment

Through collection and treatment of contaminated overburden and shallow bedrock groundwater, leachate, gas emissions and sediments, the phase III remedy at the Charles George Landfill protects human health and environment against risks posed by these media. Human health and the environment should not be jeopardized by the residual deep bedrock groundwater plume, but any unknown risks posed by this groundwater will be detected for further remedial consideration through groundwater monitoring.

The Agency's risk analysis concludes that upon successful implementation of this remedy, most probable total site risks, excluding risks due to arsenic at or below its MCL, range from an ICR of 1.2×10^{-5} to 8.9×10^{-6}, depending on the exposure scenario. Risks above these levels due to groundwater arsenic concentrations at or below the MCL are considered adequately protective because of the conservativeness and scientific uncertainties associated with the arsenic risk level. Table 3-6 of the FS lists the multimedia risk assessment exposure scenarios and the total site risk results. This table used 4000 feet eastward for the exposure point of deep bedrock groundwater because this is the distance of the closest existing deep bedrock residential well within the projected path of the plume.

B. The selected remedy attains ARARs

Except for the attainment of SDWA MCL's for benzene, arsenic, and possibly cadmium in the existing residual eastern deep bedrock plume, this remedy will meet or attain all applicable or relevant and appropriate federal and state requirements that apply to the site. Environmental laws which are applicable or relevant and appropriate to the selected remedial actions at the site include the:

Resource Conservation and Recovery Act (RCRA)
Clean Water Act (CWA)
Safe Drinking Water Act (SDWA)
Clean Air Act (CAA)
Executive Order 11990 (Protection of Wetlands)

Table 12 and Table 13, taken from Chapter 2 of the FS, list the chemical specific and location specific ARARs, respectively, and outline the action which will be taken to attain the ARARs. Table 14 indicates the action specific ARARs, presents a brief synopsis of the requirements, and outlines the action which will be taken to attain the ARARs. A brief narrative summary of the ARARs follows:

As explained in Table 10 - criterion 7, extraction of the contaminated shallow groundwater aquifers to the east and southwest of the site will comply with RCRA corrective-action and SDWA MCL ARARs since these aquifers will be extracted until contaminant levels are below respective MCL's throughout these aquifers up to the landfill boundary.

Also explained in Table 10 - criterion 7 and on pp. 30 - 31, the monitoring-only remedy for the eastern deep bedrock plume is expected to result in non-attainment of SDWA MCL's for about 1000 feet eastward from the plume's present location. However, due to the site-specific factors involved - including the technical infeasibility of extracting the entire deep bedrock plume, the presence of municipal water supply, scientific uncertainties associated with the risks of arsenic, and surface features above the plume's predicted migratory path - the residual deep plume was not selected for extraction. Since all aquifers in the area are classified as Class I and potentially drinkable, SDWA MCL's are considered ARARs for the deep bedrock plume as well as the other southwestern and eastern plumes. Thus, SDWA MCL ARARs for benzene, arsenic, and possibly cadmium are not expected to be immediately attained within the eastern deep bedrock plume.

Groundwater modeling indicates that natural attenuation should provide for the attainment of arsenic and cadmium MCL's before the plume travels 500 feet eastward. Benzene concentrations, however, could remain above the MCL for distances up to approximately 1000 feet eastward. Also, the Agency's risk analysis estimates that, excluding the uncertain risks due to arsenic, acceptable risk values will be attained in the deep plume before it travels 500 feet eastward.

Concerning other ARARs associated with groundwater and leachate, the extracted groundwater and leachate will be treated until it meets CWA discharge requirements and SDWA MCL's. Regardless of whether the discharge is to groundwater or surface water, the appropriate discharge requirements will be met. Also, the ultimate disposal of treatment residuals will comply with RCRA Subtitle C requirements for hazardous waste disposal regardless of whether this sludge is disposed on site or off site.

Concerning the vent emission remedy, NAAQS ARARs will be attained, as explained on p. 29, and State AAL's will be considered. The target levels for VOC's are based on potential on-site health risks, and in some cases are greater than the AAL's. Atmospheric dilution should allow for attainment of AAL's in off-site neighborhoods, however.

The sediment remedy will comply with EO 11990 and §404 of the CWA (40 CFR Part 230) in that the remedial design sediment sampling will be used to limit the wetland area impacted to that required only for the protection of human health and the environment. The only practicable alternative to protecting human health and the environment from the contaminated sediments is to cap the sediments in place. This alternative has more adverse impacts associated with it, however, including heavier losses to terrestrial and aquatic habitats and lower benthic recolonization potentials. The selected remedy's requirements for oil booms, silt screens and wetland restoration also comply with the requirements of EO 11990 and the CWA §404 for inclusion of all practicable measures to minimize harm to wetlands.

C. The selected remedial action is cost-effective, and uses permanent solutions and alternative treatment technologies to the maximum extent practicable

Of those remedial alternatives that are protective and attain ARARs, EPA selected remedial alternatives that are both cost-effective and utilize permanent solutions to the maximum extent practicable, based on balancing short and long term effectiveness, implementability, reduction of toxicity, mobility and volume, and cost. As previously discussed, it is impracticable to attain a permanent solution, with any certainty, for deep bedrock contamination.

Once the contaminated sediments are solidified and permanently disposed beneath the landfill cap, successful implementation of both the on-site biological-based groundwater and leachate treatment plant and the fume incinerator will result in a long-term solution to the remaining environmental problems at the site. These two treatment systems offer the best capabilities for attaining their respective target levels and discharge requirements over the long-term. Given that the landfill will remain capped where it is, these two treatment systems represent permanent solutions to the maximum extent practicable.

The selected remedies for contaminated groundwater, leachate, vent emissions and sediments are cost-effective in attaining permanency. The biological-based groundwater and leachate treatment plant is comparable in cost to the other on-site alternatives, given the accuracy of the cost estimate, yet it should provide more permanent attainment of discharge levels. As compared to the off-site treatment facility, it represents the same degree of permanency in remediating contaminated groundwater, but its costs are significantly less. Regarding the vent emission remedy, costs for the gas flaring or gas recovery alternatives are estimated to be fifty-seven percent and seventy-eight percent of the costs for incineration, respectively, yet incineration offers significantly more permanence in attaining all the gaseous VOC target levels. As for the sediment remedy, on-site disposal without treatment would cost less, but it would offer less permanence as compared to on-site disposal with solidification. The other sediment alternatives are all more costly while not attaining a significantly greater degree of permanency. All the phase III remedial design and implementation costs are presented in Table 15.

In-site sediment capping was the principle alternative technology carried through detailed analysis. For reasons discussed in section IX.C, however, it was not considered adequately protective or permanent. The gas recovery (electrical generation) vent emission remedy was the only resource recovery technology considered, but as previously discussed in Section IX.B, it was not considered as effective as flaring or incineration. The selected sediment alternative involving solidification of PAH's, however, represents an innovative technology since bench-scale testing will be required to determine the effectiveness of various additives at immobilizing the PAH's within the solid sediment matrix.

D. The selected remedy satisfies the preference for treatment as a principle element

The selected alternatives for treatment of contaminated groundwater and leachate, incineration of vent emissions, and solidification and disposal (capping) of contaminated sediments all employ treatment as a principle element.

FIGURES AND TABLES

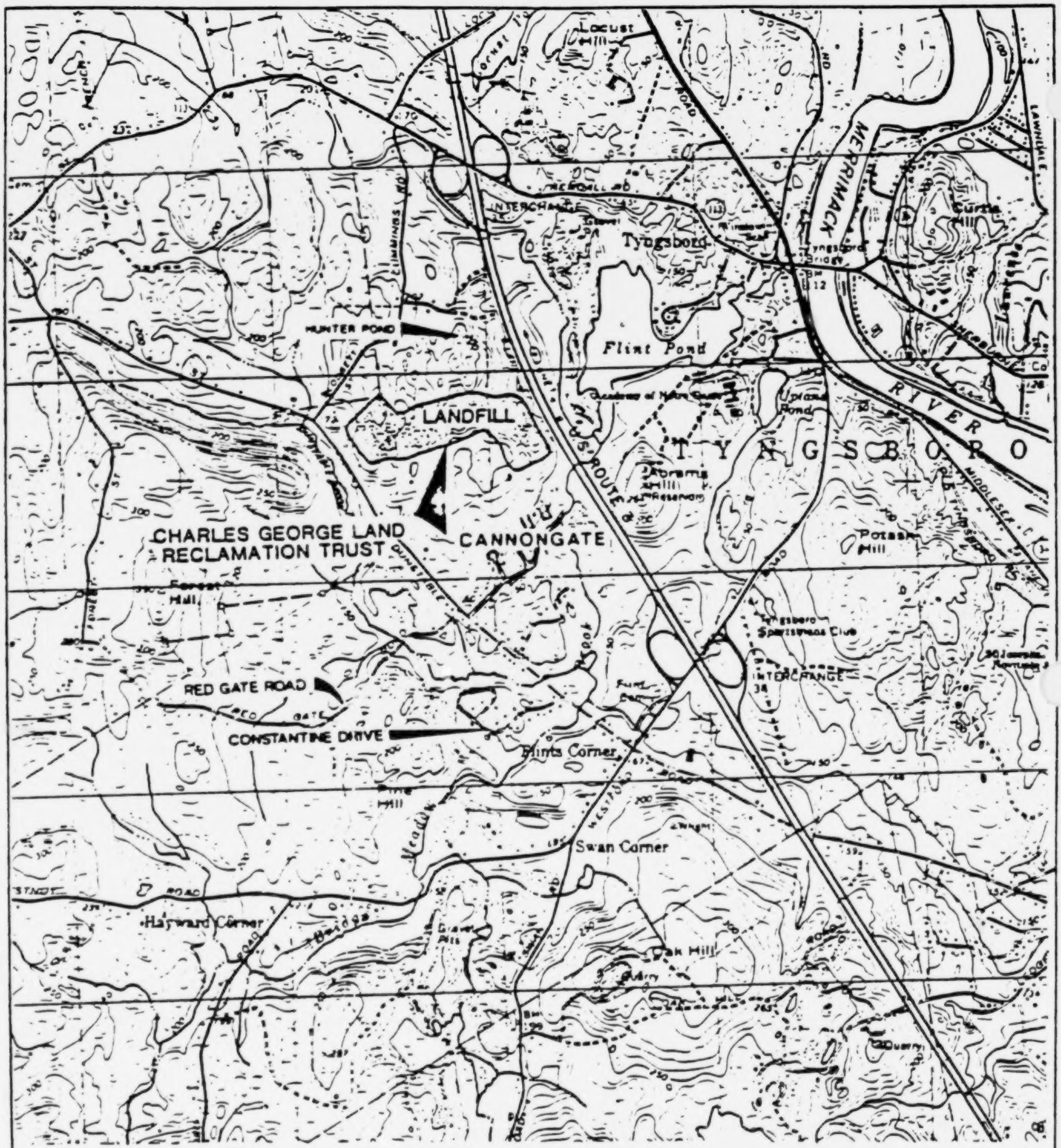
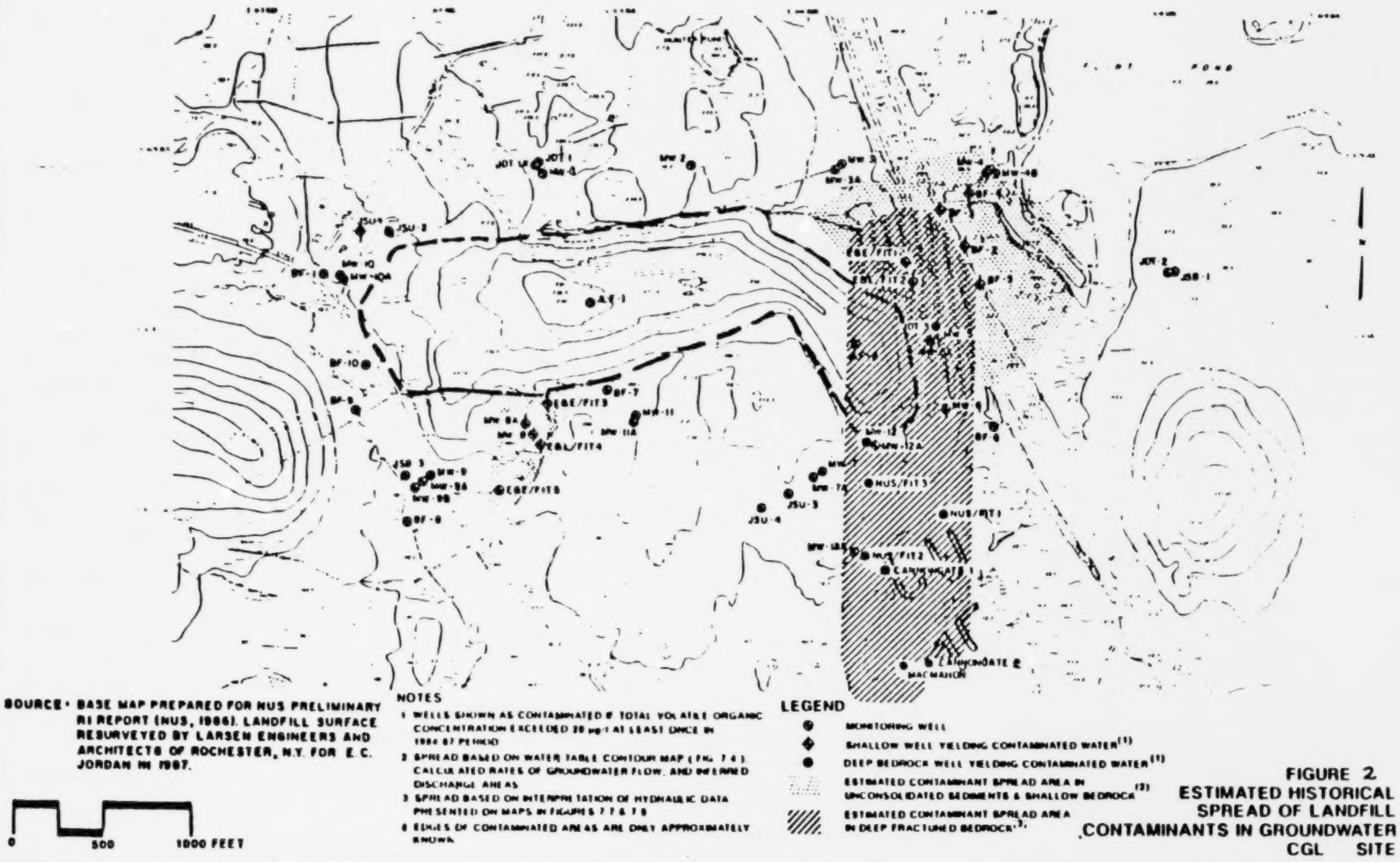

Locust Hill
MERRIMACK
RIVER
Curtis Hill
INTERCHANGE
Tyngsboro
Tyngsboro Bridge
HUNTER POND
Flint Pond
Upland Pond
LANDFILL
TYNGSBORO
ROUTE 3
Abrams Hill
CHARLES GEORGE LAND
RECLAMATION TRUST
CANNONGATE
Potash Hill
Forest Hill
Tyngsboro Sportsmens Club
INTERCHANGE 35
RED GATE ROAD
CONSTANTINE DRIVE
Flints Corner
Pine Hill
Swan Corner
Hayward Corner
Oak Hill
Quarry
MASS
QUADRANGLE LOCATION
N
Route of new waterline
0
2000
4000 FEET

FIGURE 1
SITE LOCATION MAP


PONO
MW-3
MW-3A
MW-2
JOT 1
JSU-2
MW-10
MW-10A
BF-1
BF-10
BF-9
BF-7
EBE/FIT3
MW-11
MW-11A
CGL/FIT4
JSU-3
MW-9
MW-9A
MW-9B
BF-8
EBE/FIT5
JSU-4
JSU-3
MW-7A
MW-12
MW-12A
NUS/FIT3
NUS/FIT1
NUS/FIT2
MW-13B
EBE/FIT1
EBE/FIT2
JOT 3
MW-6
BF-6
BF-2
BF-3
MW-4
MW-4B
JOT-2
JSB-1
CANNONDATE 1
CANNONDATE 2
MACMAHON
0
500
1000 FEET

SOURCE: BASE MAP PREPARED FOR NUS PRELIMINARY RI REPORT (NUS, 1986). LANDFILL SURFACE RESURVEYED BY LARSEN ENGINEERS AND ARCHITECTS OF ROCHESTER, N.Y. FOR E.C. JORDAN IN 1987.

NOTES

1. WELLS SHOWN AS CONTAMINATED IF TOTAL VOLATILE ORGANIC CONCENTRATION EXCEEDED 20 µg/l AT LEAST ONCE IN 1984-87 PERIOD
2. SPREAD BASED ON WATER TABLE CONTOUR MAP (FIG. 7.4), CALCULATED RATES OF GROUNDWATER FLOW, AND INFERRED DISCHARGE AREAS
3. SPREAD BASED ON INTERPRETATION OF HYDRAULIC DATA PRESENTED ON MAPS IN FIGURES 7.7 & 7.8
4. EDGES OF CONTAMINATED AREAS ARE ONLY APPROXIMATELY KNOWN

LEGEND

● MONITORING WELL
◆ SHALLOW WELL YIELDING CONTAMINATED WATER(1)
● DEEP BEDROCK WELL YIELDING CONTAMINATED WATER(1)
░ ESTIMATED CONTAMINANT SPREAD AREA IN UNCONSOLIDATED SEDIMENTS & SHALLOW BEDROCK(2)
▨ ESTIMATED CONTAMINANT SPREAD AREA IN DEEP FRACTURED BEDROCK(3)

FIGURE 2
ESTIMATED HISTORICAL SPREAD OF LANDFILL CONTAMINANTS IN GROUNDWATER
CGL SITE

5037 10

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TABLE 1

Maximum Chemical Concentrations in Groundwater (ug/l)
Charles George Landfill - 1987

Chemical	South Western Overburden[1]	South Western Shallow bedrock[2]	Eastern Overburden[3]	Eastern Shallow bedrock[4]	Eastern deep bedrock[5]	MCL
acetone		560 J[6]				
2 butanone (MEK)		190 J	40 J	5700 J	3300 J	
benzene	229	8 J	14		69 J	5
toluene	710	440		590	320	
ethyl benzene	28 J	18 J			24 J	
xylenes		20 J	6			
4-methyl-2 pentanone	450 J	150			36 J	
1,1-dichloro ethane	16 J		6			
phenol	21					
benzoic acid	110	36 J	430	63 J	90 J	
4-methyl phenol	140	220	18			
bis-(2-ethyl hexyl)phthalate			12	12	40	
aluminum	231		433			
arsenic	249		70	110 J	93 J	50[7]
barium	288			467	442	1000
cadmium			6	12	19	10
chromium	16		20			50
cobalt	50			69	72	
copper						
iron	38800		29300	95000		
lead						50
manganese	13600		38700	239000	173000	
mercury			0.2		0.6 J	2
nickel	152			70	72	
silver			93 J	19		50
sodium	137000		169000	51900	35100 J	
zinc	130		40	261	1960	

TABLE 1 (continued)

Footnotes

1. Data are from monitoring wells E & E/FIT 3, E & E/FIT4, and MW-8A (January - March 1987).

2. Data are from monitoring well MW-8 (May 28, 1987). Data are not available for dissolved metals, however, since the groundwater samples were not properly filtered.

3. Data are from monitoring wells E & E/FIT 2, MW-5A and BF-5 (January - March 1987).

4. Data are from monitoring wells MW-5 and JDT-3 (C) (January-March 1987).

5. Data are from monitoring wells NUS/FIT1, NUS/FIT2 and JDT-3 (A & B)) (January - March 1987).

6. "J" indicates the concentration value is estimated.

7. The current MCL for arsenic is 50 ug/l, the listed value is the currently proposed arsenic MCL.

Table 2

Maximum Chemical Concentrations in Leachate

Charles George Landfill
1984 - 87

CHEMICAL	CONCENTRATION (µg/ℓ)
Acetone	22,000.00
2-Butanone	21,000.00
4-Methyl-2-Pentanone	1,800.00
Toluene	700.00
Ethylbenzene	140.00
Total Xylenes	160.00
1,1,2,2-Tetrachloroethane	310.00
1,1,2-Trichloroethane	25.00
1,1-Dichloroethane	83.00
Trichloroethene	24.00
Trans-1,2-Dichloroethene	290.00
Vinyl Chloride	250.00
Chloroform	20.00
Methylene Chloride	7,200.00
Benzoic Acid	38,000.00
Phenol	3,000.00
4-Methylphenol	12,000.00
Heptachlor	0.12
Aluminum	73,400.00
Antimony	496.00
Arsenic	342.00
Barium	843.00
Beryllium	153.00
Cadmium	483.00
Calcium	2,000,000.00
Chromium	242.00
Cobalt	57.00
Copper	229.00
Iron	817,000.00
Lead	110.00
Magnesium	367,000.00
Manganese	242,000.00
Mercury	2.70
Nickel	1,020.00
Potassium	342,000.00
Sodium	858,000.00
Tin	113.00
Vanadium	0.00
Zinc	2,900.00

Table 3

Landfill Gas Vent Emissions
Charles George Landfill
1984 - 87

CHEMICAL	AVERAGE VENT CONCENTRATION $(\mu g/m^3)$[1]
1,1-dichloroethene	6,073[2]
1,1,2,2-tetrachloroethane	52[2]
methylene chloride	31,692[2]
vinyl chloride	26,960[2]
1,2-dichloroethane	15,200[3]
benzene	7,110[3]
1,1,2-trichloroethane	379[3]
trichloroethene	17,887[2]
carbon tetrachloride	26,500[3]
tetrachloroethene	12,155[2]
chloroform	962[2]
bromoform	5.69×10^6[3]

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[1] Highest average concentration from NUS data or REM III data for specific vents.

[2] Highest average concentration found in either of two NUS data sets (1984-1985, 1986).

Highest concentration from REM III sampling of two landfill vents, 1987.

Table 4
Maximum Chemical Concentrations in Residential Ambient air (ug/m^3)
Charles George Landfill
1987-88[1]

Carcinogens	Hoare Property	Flint Pond	Cannongate
methylene chloride	>5.26[2]	>3.30	>2.88
1,2-dichloroethane	BDL	BDL	>2.88
benzene	2.90	>3.30	>2.88
chloroform	0.53	1.63	0.43
carbon tetrachloride	0.17	1.63	2.16
1,1,2,2-tetrachloroethane	BDL	4.88	BDL
tetrachloroethene	BDL	4.88	BDL
trichloroethene	BDL	BDL	4.9
Non-carcinogens			
bromomethane	BDL	BDL	0.29
bromoform	BDL	0.17	BDL
chlorobenzene	0.76	2.44	0.53
toluene	5.26	>3.3	>2.88
1,1,1-trichloroethane	BDL	1.7	1.4
xylenes	BDL	BDL	2.4

(1) Data from Ebasco sampling (1987) and EPA, Region I Sampling (1988).

(2) > indicates that the mass of the contaminant exceeded the calibration range of the method. The true value is thus greater than the listed value.

(3) BDL = Below Detection Limit

TABLE 5

CONTAMINANT LEVELS FOR SEDIMENTS FROM DUNSTABLE BROOK[a]

Sampling Site	Carcinogenic PAHs[b] (mg/kg)	Arsenic (mg/kg)	Cadmium (mg/kg)
East of Dunstable Road			
ECJ #24	1.54	--	4.80
ECJ # 8	5.30	16.0	4.10
Upstream of Outfall (background)			
NUS #8	--	5.0	--
NUS #9	--	5.0	--
Dunstable Brook Outfall			
NUS # 7	2.32	14.0	0.22
NUS #13	1.63	7.5	0.40
ECJ # 2	0.87	4.9	3.10
Dunstable Brook, Lower			
NUS # 6	--	17.0	0.21
NUS #14	--	8.6	--
ECJ # 3	--	7.0	--
ECJ #11	--	7.6	--

---

[a] Includes NUS data (1984, 1985) and E.C. Jordan data (1987).

[b] Carcinogenic PAHs include: benzo(a)pyrene, benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, indeno (1,2,3-cd) pyrene, and chrysene.

Table 6

CGL Contaminants of Concern - Phase III

Contaminant	Medium effected		
	Groundwater and Leachate	Air	Sediment
2-butanone (MEK)	X		
toluene	X	X	
acetone	X		
benzene	X	X	
4-methyl 2-pentanone	X		
ethyl benzene	X		
1,1-dichloethene	X	X	
trichloroethene	X	X	
1,2-dichloroethane		X	
methylene chloride		X	
chloroform		X	
1,1,2,2-tetrachloroethane		X	
vinyl chloride		X	
tetrachloroethene		X	
carbon tetrachloride		X	
1,1,2-trichloroethane		X	
chlorobenzene		X	
carbon disulfide		X	
xylenes		X	
bromomethane		X	
bromoform		X	
benzoic acid	X		
4-methyl phenol	X		
2-methyl phenol	X		
phenol	X		
PAH's			X
arsenic	X		X
chromium	X		
copper	X		
mercury	X		
cadmium	X		X

TABLE 7
Summary of CGL Risk Assessment

Exposure Medium	Individual Incremental Cancer Risk		Hazard Index	
	Most Probable	Worst Case	Most Probable	Worst Case
I. Groundwater				
A. Southwestern Plume				
1. Overburden	1.8×10^{-2}	2.2×10^{-2}	0.90	1.09
2. Shallow bedrock[1]	6.6×10^{-6}		1.1	1.4
B. Eastern Deep Groundwater[2]				
1. 500 ft			0.75	
a. all contaminants	6.9×10^{-4}			
b. arsenic excluded	4.3×10^{-5}			
2. 1000 ft			0.27	
a. all contaminants	2.8×10^{-4}			
b. arsenic excluded	1.7×10^{-5}			
3. 2000 ft			0.10	
a. all contaminants	9.4×10^{-5}			
b. arsenic excluded	5.2×10^{-6}			
4. 4000 ft			0.03	
a. all contaminants	3.7×10^{-5}			
b. arsenic excluded	2.3×10^{-6}			
II. Air				
A. On sight[3]				
1. 1984-86	5.2×10^{-5}	4.6×10^{-4}	0.004	0.052
2. 1987	3.0×10^{-4}	1.2×10^{-3}	2.0	8.0
B. Off sight				
1. 1987[3]				
a. Flint Pond	1.2×10^{-5}	4.2×10^{-4}	0.007	0.26
b. Cannongate Pond	4.1×10^{-6}	1.5×10^{-4}	0.007	0.26
c. Abandoned House	1.7×10^{-6}	6.2×10^{-5}	0.001	0.037
2. Present Modeled Risk[4]				
a. Flint Pond	1.1×10^{-6}		<< 1	
b. Cannongate	5.6×10^{-6}		<< 1	
c. Abandoned House	5.6×10^{-6}		<< 1	
3. Future Modeled Risk[4]				
a. Flint Pond	2.8×10^{-7}		<< 1	
b. Cannongate	1.1×10^{-6}		<< 1	
c. Abandoned House	5.2×10^{-7}		<< 1	
III. Sediment				
A. Dunstable Brook[5]	$>1.2\times10^{-6}$	$>9.2\times10^{-6}$		0.03
B. Flint Pond Marsh	1.0×10^{-8}	1.6×10^{-5}		0.06
C. Flint Pond	9.9×10^{-9}	5.9×10^{-6}		0.002

IV. Biota[6]	$<4\times10^{-7}$	$<7\times10^{-6}$	0.22	0.36
V. Surface water				
A. Flint Pond Marsh		$<1\times10^{-7}$		<1
B. Flint Pond		$<1\times10^{-8}$		.003

Footnotes

1. The carcinogenic risk assessment for shallow bedrock is based solely on an estimated benzene concentration of 8 ppb from one sampling episode.

2. The risk assessment for this plume is based on estimated contaminant concentrations at varying distances east of the site based on groundwater modeling. Risks with and without arsenic are differentiated since the estimated arsenic concentrations are below the arsenic MCL.

3. These on-site and off-site risks are based on actual, monitored concentrations from NUS (1984-85) and Ebasco (1987) sampling.

4. Present and future modeled risks were based on Ebasco's air modeling of the existing, uncapped landfill (flux method) and the future, capped and vented landfill (vent method), respectively.

5. Risks due to sediment PAH's in the western pump station tributary to Dunstable Brook are assumed to be greater than the listed value. These listed values are for risks downstream of the confluence of the tributary and the Brook. Although no sediment data exist for the tributary, PAH contamination is clearly higher here than after confluence with the brook.

6. Biota ICR risks are qualified as maximum risks because these risks are based on arsenic found in turtle tissue and not in fish tissue.

TABLE 8

TARGET CLEANUP LEVELS
CHARLES GEORGE LANDFILL

Remediation Area	Basis for Target Level	Contaminant	Target Cleanup Level
Shallow Groundwater Southwest	ARAR-based using MCL for benzene and arsenic	Benzene	0.005 mg/ℓ (MCL for benzene)
		Arsenic	0.050 mg/ℓ (MCL for arsenic)
Shallow Bedrock and Overburden Groundwater, East	ARAR-based using MCL for benzene, arsenic, TCE, cadmium, and silver	Benzene	0.005 mg/ℓ (MCL for benzene)
		Trichloroethene	0.005 mg/ℓ (MCL for TCE)
		Arsenic	0.050 mg/ℓ (MCL for arsenic)
		Cadmium	0.010 mg/ℓ (MCL for cadmium)
		Silver	0.050 mg/ℓ (MCL for silver)
Sediments, All Areas	Risk-based using risk level of $4x10^{-6}$	PAHs	1.0 mg/kg (based on risk level of $4x10^{-6}$
[illegible] Emissions , On site	Risk-based using cumulative risk level of $1x10^{-6}$ and most-probable on-site exposure scenario	1,1-dichloroethene	12.7 $\mu g/m^3$
		1,1,2,2-tetrachloroethane	73.9 $\mu g/m^3$
		methylene chloride	1,030 $\mu g/m^3$
		vinyl chloride	591 $\mu g/m^3$
		1,2-dichloroethane	422 $\mu g/m^3$
		benzene	568 $\mu g/m^3$
		1,1,2-trichloroethane	258 $\mu g/m^3$
		trichloroethene	3,210 $\mu g/m^3$
		carbon tetrachloride	114 $\mu g/m^3$
		tetrachloroethene	8,690 $\mu g/m^3$
		chloroform	182 $\mu g/m^3$
		bromoform	$3.23x10^5$ $\mu g/m^3$

TABLE 9

Technologies Identified and Screened in the FS

Groundwater and Leachate:

1. Groundwater monitoring
2. Slurry walls[1]
3. Trench drains
4. Extraction wells
5. Metals precipitation
6. Aerobic/anaerobic[1] biological treatment
7. Air/steam[1]-stripping
8. UV/ozonation[2]
9. Reverse osmosis[1]
10. Activated carbon adsorption
11. Clarificationsedimentation
12. Filtration
13. Chemical oxidation
14. Ion-exchange
15. Liquid-liquid extraction[1]

16. Supercritical water oxidation[1]
17. Off-site treatment at a RCRA facility
18. Off-site treatment at a Publicly Owned Treatment Works (POTW)
19. Reinjection of treated water into groundwater
20. Discharge of treated water to surface water

TABLE 9 (continued)

Landfill Gas:

1. Condensation/acid-scrubbing
2. Carbon adsorption[2]
3. Molecular sieves[2]
4. Flaring
5. Incineration
6. Combustion (electrical generation)
7. Atmospheric discharge
8. Discharge to natural gas pipeline

Sediment:

1. In-situ capping
2. Biodegradation[1]
3. Incineration
4. Molten glass electric reactor[2]
5. Thermal aeration
6. Solvent extraction[1]
7. Vitrification[1]

[1] Eliminated in preliminary screening in Chapter 4

[2] Eliminated in Chapter 6 initial screening

TABLE 10

EVALUATION OF REMEDIAL ALTERNATIVES BASED ON NINE CRITERIA

ALTERNATIVE	CRITERION 1: COST
Groundwater No-Action (GW-1)	Estimated Capital Cost: $151,000. Estimated Annual O&M Cost: $113,000. Estima Present Worth: $1,216,000.
roundwater and Leachate Alternatives	
Carbon Adsorption (GW-2)	Estimated Capital Cost: $2,995,000. Estimated Annual O&M Cost: $686,000. Estimated Present Worth Cost: $9,809,000.
Air-Stripping (GW-3)	Estimated Capital Cost: $2,893,000 Estimated Annual O&M Cost: $675,000 Estimated Present Worth Cost: $9,792,000
Biological Treatment (GW-5)	Estimated Capital Cost: $3,318,000. Estimated Annual O&M Cost: $594,000. Estimated Present Worth Cost: $8,800,000
Off-Site Treatment (GW-6)	Estimated Capital Cost: $1,861,000. Estimated Annual O&M Cost: $12,259,000. Estimated Present Worth Cost: $117,397,000.
ndfill Gas Alternatives	
No Action (GAS-1)	No immediate costs.
Gas Flaring (GAS-3)	Estimated Capital Cost: $237,000. Estimated Annual O&M Cost: $37,000. Estimated Present Worth Cost: $586,000.
Incineration (GAS-4)	Estimated Capital Cost: $959,000. Estimated Annual O&M Cost: $8,000. Estimated Present Worth Cost: $1,034,000.
Combustion Recovery (GAS-5)	Estimated Capital Cost: $1,658,000. Estimated Annual O&M Cost: -$90,000. Estimated Present Worth Cost: $809,000.
diment Alternatives	
No Action (SED-1)	No immediate costs.
In-Situ Capping (SED-2)	Estimated Capital Cost: $98,300. Estimated Annual O&M Cost: $4,900. Estimated Present Worth Cost: $144,200.
On-Site Disposal (SED-7)	Estimated Total Cost: $40,800.
On-Site Solidification and Disposal (SED-3)	Estimated Total Cost: $79,000.
On-Site Thermal Aeration and Disposal (SED-4)	Estimated Total Cost: $915,000.
Off-Site Solidification and Disposal (SED-5)	Estimated Total Cost: $208,000.
Off-Site Incineration and Disposal (SED-6)	Estimated Total Cost: $1,404,700.

TABLE 10 (cont.)

EVALUATION OF REMEDIAL ALTERNATIVES BASED ON NINE CRITERIA

ALTERNATIVE	CRITERION 2: IMPLEMENTABILITY
1 [illegible]oundwater No-Action (GW-1)	Installation and maintenance of new groundwater monitoring wells required. Could be easily and quickly implemented.
Groundwater and Leachate Alternatives	
2. Carbon Adsorption (GW-2)	Treatment equipment is well proven and reliable. Lawful sludge disposal would be required. Dunstable Brook discharge could be implemented more easily than a Merrimack River discharge since the latter would require easements for wetlands, highways, and a railroad. Further investigation needed for groundwater discharge. Approximately 2 1/2 years required for design and construction.
3. Air-Stripping (GW-3)	Same implementability concerns as for GW-2.
4. Biological Treatment (GW-5)	Same implementability concerns as for GW-2. Also, approximately 15% more sludge by weight would require disposal. Bench- or pilot-scale testing recommended to assess potential for microbial toxicity problems. Would require careful operation since the biological system may be sensitive to changes in influent quantity and quality.
5. Off-Site Treatment (GW-6)	Discharge to a POTW could not presently be implemented (see Table 7-21 in FS). Discharge to a RCRA facility considered feasible but would require long-term contracts and would be dependent on compliance of the RCRA facility.
Landfill Gas Alternatives	
6. No Action (GAS-1)	Not applicable.
7. Gas Flaring (GAS-3)	Technically feasible; easily implemented. 13 months for design and construction.
8. Incineration (GAS-4)	Technically feasible; easily implemented. 16 months necessary for design and construction.
9. Combustion Recovery (GAS-5)	Technically feasible. Coordination with the landfill cap construction project for the drilling of the deep gas wells could push the design and construction time for this alternative beyond the estimated 17 months otherwise required. Contract with local utility required.
Sediment Alternatives	
10. No Action (SED-1)	Not applicable.
11. In-Situ Capping (SED-2)	Technically feasible. Construction would take approximately six months.
12. On-Site Disposal (SED-7)	Technically feasible. Coordination with landfill cap construction project required. Three to six months necessary for total operation.
13. On-Site Solidification and Disposal (SED-3)	Technically feasible. Coordination with the landfill cap construction project and testing of additives required. Three to six months necessary for total operation.
14. On-Site Thermal Aeration and Disposal (SED-4)	Technically feasible; thermal aeration equipment is available. Coordination with the landfill cap construction project required. Moisture content of the sediments could cause performance or operating problems. Three to six months necessary for total operation.
15. Off-Site Solidification and Disposal (SED-5)	Technically feasible. No coordination with cap construction required. Six months necessary for total operation.
16. Off-Site Incineration and Disposal (SED-6)	Technically feasible. Incinerator availability could be a problem. No coordination with cap construction required. 3-6 months necessary for total operation.

TABLE 10 (cont.)

EVALUATION OF REMEDIAL ALTERNATIVES BASED ON NINE CRITERIA

ALTERNATIVE	CRITERION 3: OVERALL PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT
1. Groundwater No-Action (GW-1)	Unprotective. Risks posed via groundwater would not be eliminated, reduced or controlled.
Groundwater and Leachate Alternatives	
2. Carbon Adsorption (GW-2)	Provides adequate protection against groundwater risks by extracting contaminated groundwater and treating it together with leachate.
3. Air-Stripping (GW-3)	Same overall protectiveness as with GW-2.
4. Biological Treatment (GW-5)	Same overall protectiveness as with GW-2.
5. Off-Site Treatment (GW-6)	Assuming off-site treatment complies with RCRA standards, this alternative offers more protection to the local environment compared to the other groundwater and leachate alternatives since there would be no discharge of treated water.
Landfill Gas Alternatives	
6. No Action (GAS-1)	Unprotective. Risks posed via gaseous landfill emissions would not be eliminated, reduced or controlled.
7. Gas Flaring (GAS-3)	Of the three gas treatment alternatives (GAS-3, GAS-4, and GAS-5), this alternative is more protective than combustion/gas recovery but less protective than incineration. Estimated VOC removal efficiencies for flaring, incineration and combustion/gas recovery are 95%, >99%, and 90%, respectively. Based on these rates, this alternative may not attain clean-up levels.
8. Incineration (GAS-4)	More protective than all other landfill gas alternatives. Target clean-up levels would be achieved if designed and operated properly.
9. Combustion Recovery (GAS-5)	Least protective of the three gas treatment alternatives, but more protective than the no-action alternative.
Sediment Alternatives	
10. No Action (SED-1)	Unprotective. Risks posed by sediment contaminants would not be eliminated, reduced or controlled.
11. In-Situ Capping (SED-2)	Since contaminated sediments in Dunstable Brook would be contained only, sediment clean-up levels would not be attained. This alternative would not present appreciable human health risks, but it does not adequately protect the environment. Benthic recolonization potential would be the lowest for this alternative than for Alternatives SED-3 - SED-7.
12. On-Site Disposal (SED-7)	As with all the remaining alternatives involving excavation, some temporary destructive environmental effects would occur. Contaminants would be removed, however, and the area would be restored to its original state. Thus this alternative and the remaining alternatives offer overall protection to the environment. Human health would also be adequately protected.
13. On-Site Solidification and Disposal (SED-3)	Adequate protection of human health and the environment.
14. On-Site Thermal Aeration and Disposal (SED-4)	Adequate protection of human health and the environment.
15. Off-Site Solidification and Disposal (SED-5)	Adequate protection of human health and the environment.
16. Off-Site Incineration and Disposal (SED-6)	Adequate protection of human health and the environment.

TABLE 10 (cont.)

EVALUATION OF REMEDIAL ALTERNATIVES BASED ON NINE CRITERIA

ALTERNATIVE	CRITERION 4: SHORT-TERM EFFECTIVENESS
1. [illegible]ndwater No-Action (GW-1)	Not applicable.
Groundwater and Leachate Alternatives	
2. Carbon Adsorption (GW-2)	All three on-site groundwater and leachate treatment alternatives (GW-3, GW-4, and GW-5) are equally effective in the short-term since all would take about 2 1/2 years to design and construct.
3. Air-Stripping (GW-3)	Equivalent to GW-3 in start up requirements. Air emissions would be generated throughout implementation.
4. Biological Treatment (GW-5)	Equivalent to GW-3 in start-up requirements.
5. Off-Site Treatment (GW-6)	Could be implemented sooner than the on-site alternative assuming administrative problems with a RCRA-compliant facility would be overcome.
andfill Gas Alternatives	
6. No Action (GAS-1)	Not applicable.
7. Gas Flaring (GAS-3)	Could be implemented somewhat faster than GAS-4 and GAS-5 (13 months verses 16 and 17 months, respectively). Secondary pollutants would be created by the combustion process in all three treatment alternatives.
8. Incineration (GAS-4)	Could be implemented sooner than gas recovery, but would take longer to implement than flaring.
9. Combustion Recovery (GAS-5)	Of the three gas treatment alternatives, this would take the longest to implement. Construction of the deep gas wells would release gaseous contaminants causing adverse impacts to human health and the environment.
ediment Alternatives	
10. N[illegible]ction (SED-1)	Not applicable.
11. In Situ Capping (SED-2)	All remaining sediment alternatives would have temporary negative environmental impacts due to construction of a temporary access road. The area would be restored, however.
12. On-Site Disposal (SED-7)	Temporary access road required.
13. On-Site Solidification and Disposal (SED-3)	Temporary access road required.
14. On-Site Thermal Aeration and Disposal (SED-4)	Temporary access road required. Vapor-phase PAHs would need treatment before discharge.
15. Off-Site Solidification and Disposal (SED-5)	Temporary access road required.
16. Off-Site Incineration and Disposal (SED-6)	Temporary access road required.

TABLE 10 (cont.)

EVALUATION OF REMEDIAL ALTERNATIVES BASED ON NINE CRITERIA

ALTERNATIVE	CRITERION 5: LONG-TERM EFFECTIVENESS AND PERMANENCE
1. Groundwater No-Action (GW-1)	Would not maintain reliable protection of human health and the environment.
Groundwater and Leachate Alternatives	
2. Carbon Adsorption (GW-2)	Of the three on-site groundwater and leachate alternatives which offer overall protection to human health and the environment, GW-2 should be most prone to reliability problems since carbon adsorption is the only treatment unit in this alternative able to remove organic contaminants. Carbon adsorption has not been proven effective in removing acetone, 2-butanone and benzoic acid.
3. Air-Stripping (GW-3)	Should offer more reliability than GW-2 since both air-stripping and carbon adsorption units could remove organic contaminants. Could be less reliable than GW-5, though, since 2-butanone, acetone, and benzoic acid may not be effectively removed.
4. Biological Treatment (GW-5)	GW-5 offers the best long-term effectiveness at removing site contaminants, especially 2-butanone, acetone, and benzoic acid. This alternative would require careful operation since the biological system may be sensitive to changes in influent quality and quantity.
5. Off-Site Treatment (GW-6)	GW-6 could pose reliability problems in the long-term if off-site facilities became unable to accept site waste because of compliance or capacity problems.
Landfill Gas Alternatives	
6. No Action (GAS-1)	Not applicable.
7. Gas Flaring (GAS-3)	Aqueous side streams would be generated throughout implementation of this alternative. May not reliably attain cleanup goals for vapor-phase VOCs.
8. Incineration (GAS-4)	GAS-4 would be the most effective of the three gas treatment alternatives in the long-term. No side streams would be generated, and all gaseous target levels should be attained.
9. Combustion Recovery (GAS-5)	GAS-5 is considered the least effective of the three gas treatment alternatives. removal efficiencies are less and corrosion related down time is more frequent for this alternative's technology than for those of GAS-3 and GAS-4. Target levels may not be attained.
Sediment Alternatives	
10. No Action (SED-1)	Not applicable.
11. In-Situ Capping (SED-2)	SED-2 offers the least permanence and long-term effectiveness of the remaining sediment alternatives. The sediment cap would require on-going maintenance and possibly replacement.
12. On-Site Disposal (SED-7)	Since the remaining sediment alternatives involve dredging and some form of treatment and/or disposal. They are all roughly equivalent in long-term effectiveness and permanence. The varying degrees of treatment do offer minor differences in permanence, though.
13. On-Site Solidification and Disposal (SED-3)	Offers somewhat more permanence than SED-7 since the sediments would be solidified before capping.
14. On-Site Thermal Aeration and Disposal (SED-4)	Could provide more permanence than both SED-7 and SED-3 since thermal aeration could be more effective in removing PAH's than solidification is in containing PAH's.
15. Off-Site Solidification and Disposal (SED-5)	Equivalent to SED-3 in permanence.
16. Off-Site Incineration and Disposal (SED-6)	Incineration is well demonstrated for PAH removal, thus SED-6 offers the best permanence.

TABLE 10 (cont.)

EVALUATION OF REMEDIAL ALTERNATIVES BASED ON NINE CRITERIA

ALTERNATIVE	CRITERION 6: REDUCTION OF TOXICITY, MOBILITY OR VOLUME
[illegible] roundwater No-Action (GW-1)	No reduction in toxicity, mobility or volume.
Groundwater and Leachate Alternatives	
2. Carbon Adsorption (GW-2)	Toxicity and mobility of aqueous contaminants would be significantly reduced since groundwater would be extracted and treated along with leachate.
3. Air-Stripping (GW-3)	Toxicity and mobility would be significantly reduced.
4. Biological Treatment (GW-5)	Toxicity and mobility would be significantly reduced.
5. Off-Site Treatment (GW-6)	Toxicity and mobility would be significantly reduced.
Landfill Gas Alternatives	
6. No Action (GAS-1)	No reduction in toxicity, mobility or volume of gaseous contaminants.
7. Gas Flaring (GAS-3)	Would reduce toxicity of gaseous contaminants by open flaring.
8. Incineration (GAS-4)	Would offer the most reduction of gas toxicity by incineration.
9. Combustion Recovery (GAS-5)	Of the three gas treatment alternatives, GAS-5 should offer the least reduction in landfill gas toxicity.
Sediment Alternatives	
10. No Action (SED-1)	No reduction in PAH toxicity, mobility or volume.
11. In-Situ Capping (SED-2)	Capping would reduce the mobility of sediment PAHs.
12. On-Site Disposal (SED-7)	On-site disposal and capping would remove PAH mobility more than SED-2 since the sediments would be prevented from contacting groundwater.
13 [illegible]-Site Solidification [illegible] Disposal (SED-3)	On-site solidification and disposal could remove PAH mobility more than SED-7 since additives may immobilize the PAHs within the solid matrix.
14. On-Site Thermal Aeration and Disposal (SED-4)	Since on-site thermal aeration and disposal would remove PAHs from the sediments and reduce any remaining contaminant mobility via capping, SED-4 offers more reduction in contaminant mobility than SED-3.
15. Off-Site Solidification and Disposal (SED-5)	Similar advantages as with SED-4.
16. Off-Site Incineration and Disposal (SED-6)	Off-site incineration would offer the most reduction in PAH toxicity.

TABLE 10 (cont.)

EVALUATION OF REMEDIAL ALTERNATIVES BASED ON NINE CRITERIA

ALTERNATIVE	CRITERION 7: COMPLIANCE WITH ARARS
1. Groundwater No-Action (GW-1)	Since groundwater in the southwestern area of the site will potentially be use drinking water, MCLs established under the SDWA are relevant and appropriate requirements. Since MCLs for benzene and arsenic have been exceeded and are expected to continue to be exceeded in this area, no-action would not comply with the SDWA MCL ARARs. RCRA groundwater corrective action ARARs would also be unattained. Overburden and shallow bedrock groundwater to the east of the site is less likely than southwestern site groundwater to be used for drinking water since these eastern aquifers discharge primarily to Flint Pond Marsh (see Section V.A.2). Future large yield pumping of these upper aquifers in the area could potentially draw contaminants from these aquifers, however. Thus, SDWA MCLs are also relevant and appropriate for these aquifers. Arsenic, cadmium, silver, and benzene concentrations have been detected in 1987 at levels above their respective SDWA MCLs, although the magnitude of exceedances is not as significant as in the southwestern overburden. Arsenic, cadmium, and silver MCLs established under RCRA for maximum permissible levels at the downgradient property boundary were also exceeded in 1987. The landfill could potentially release further contamination to these aquifers. Thus, if contaminant concentrations remain above MCL levels in the future, no-action in the eastern shallow aquifers would not attain SDWA MCL ARARs or RCRA corrective action ARARs (40 CFR §264.92-100). The monitoring only remedy for the Eastern Deep Bedrock Plume is expected to result in non-attainment of SDWA MCLs for about 1000 feet eastward from the plume's present location. However, due to the site-specific factors involved - including the technical infeasibility of extracting the entire deep bedrock plume, the presence of municipal water supply, scientific uncertainties associated with the risks of arsenic, and surface features above the plume's predicted migratory path - the residual deep plume was not selected for extraction. Since all the aquifers in the area are classified as Class I and potentially drinkable, SDWA MCLs are considered ARARs for the deep bedrock plume. Thus, SDWA MCL ARARs for benzene, arsenic, and possibly cadmium are not expected to be immediately attained within the eastern deep bedrock plume.
roundwater and Leachate Alternatives	
Carbon Adsorption (GW-2)	GW-2, GW-3, and GW-5 all comply with RCRA and SDWA MCL ARAR's for groundwater quality. The treated discharge will comply with Massachusetts' groundwater discharge standards, or alternatively, its surface water discharge standards and Clean Water Act NPDES standards if groundwater discharge is infeasible. Sludge will be disposed in accordance with RCRA Subtitle C.
Air-Stripping (GW-3)	See comments for GW-2. Also, vapor-phase VOCs from the air-stripping unit could conceivably be tied-into the landfill gas treatment system, thereby meeting federal and state air discharge requirements.
Biological Treatment (GW-5)	See comment for GW-2 above.
Off-Site Treatment (GW-6)	The off-site facility would have to comply with RCRA requirements to be eligible.
ndfill Gas Alternatives	
No Action (GAS-1)	Requirements to be considered included in Massachusetts' Allowable Ambient Levels (AALs) would not be attained if gas emissions were to be unmitigated.

TABLE 10 (cont.)

EVALUATION OF REMEDIAL ALTERNATIVES BASED ON NINE CRITERIA

ALTERNATIVE	CRITERION 7: COMPLIANCE WITH ARARS
7. Gas Flaring (GAS-3)	Should attain AALs off-site. National Ambient Air Quality Standards (NAAQS) will t attained. Scrubbing technology will be installed to do so if monitoring demonstrat non-compliance with NAAQS (especially sulfur dioxide).
8. Incineration (GAS-4)	See comment for GAS-3 above.
9. Combustion Recovery (GAS-5)	See comment for GAS-3 above.
Sediment Alternatives	
10. No Action (SED-1)	Not applicable.
11. In-Situ Capping (SED-2)	Would not comply with Section 404 of the Clean Water Act since other alternatives are available which have less negative impact on aquatic and terrestrial habitats.
12. On-Site Disposal (SED-7)	In accordance with the Clean Water Act, the remaining sediment alternatives were developed which have less impacts on wetland habitats. Land Ban requirements for PAHs are not yet in effect. SED-7 may not comply with construction requirements fo: characteristics to be used in the capping project.
13. On-Site Solidification and Disposal (SED-3)	SED-3 would conform to fill requirements acceptable for use in the capping project.
14. On-Site Thermal Aeration and Disposal (SED-4)	Pollution control devices should allow attainment of federal and state air discharge regulations. SED-4 would not involve solidification and therefore may not comply with construction requirements.
15. Off-Site Solidification and Disposal (SED-5)	ARARs would be complied with assuming the off-site facility(ies) used are in compliance with RCRA.
16. Off-Site Incineration and Disposal (SED-6)	See comment for SED-5.

TABLE 10 (cont.)

EVALUATION OF REMEDIAL ALTERNATIVES BASED ON NINE CRITERIA

ALTERNATIVE	CRITERION 8: STATE ACCEPTANCE
1. Groundwater No-Action (GW-1)	The DEQE would not concur with groundwater "no-action" because of risks to hu [illegible] ae above Commonwealth standards.
Groundwater and Leachate Alternatives	
2. Carbon Adsorption (GW-2)	The DEQE will base concurrence with specific on-site treatment technologies on the results of bench- or pilot-scale testing of representative groundwater and leachate samples. State water quality anti-degradation regulations require alternative discharge other than into Dunstable Brook, if feasible.
3. Air-Stripping (GW-3)	See comment for GW-2 above.
4. Biological Treatment (GW-5)	See comment for GW-2 above.
5. Off-Site Treatment (GW-6)	The DEQE would not concur with GW-6 based on cost-effectiveness.
Landfill Gas Alternatives	
6. No Action (GAS-1)	Unacceptable health risks would prevent the DEQE from concurring with "no-action" for vent emissions.
7. Gas Flaring (GAS-3)	State would accept this alternative.
8. Incineration (GAS-4)	State would accept this alternative.
9. Combustion Recovery (GAS-5)	State would not accept this alternative because human health may not be protected given the lower VOC removal efficiencies associated with this alternative's technology.
Sediment Alternatives	
10. No Action (SED-1)	State concurrence on all sediment remedies will be dependent on the results of the upcoming remedial design PAH sampling.
11. In-Situ Capping (SED-2)	State concurrence on all sediment remedies will be dependent on the results of the upcoming remedial design PAH sampling.
12. On-Site Disposal (SED-7)	State concurrence on all sediment remedies will be dependent on the results of the upcoming remedial design PAH sampling.
13. On-Site Solidification and Disposal (SED-3)	State concurrence on all sediment remedies will be dependent on the results of the upcoming remedial design PAH sampling.
14. On-Site Thermal Aeration and Disposal (SED-4)	State concurrence on all sediment remedies will be dependent on the results of the upcoming remedial design PAH sampling.
15. Off-Site Solidification and Disposal (SED-5)	State concurrence on all sediment remedies will be dependent on the results of the upcoming remedial design PAH sampling.
16. Off-Site Incineration and Disposal (SED-6)	State concurrence on all sediment remedies will be dependent on the results of the upcoming remedial design PAH sampling.

TABLE 10 (cont.)

EVALUATION OF REMEDIAL ALTERNATIVES BASED ON NINE CRITERIA

ALTERNATIVE	CRITERION 9: COMMUNITY ACCEPTANCE
Groundwater No-Action (GW-1)	A remedy without any groundwater clean-up would not be accepted by the local community because the threat of contamination to residential drinking wells would remain unmitigated. Comments received during the comment period and questions asked at the public meeting and hearing; however, indicate community acceptance of the "monitoring only" remedy selected for deep bedrock groundwater. This acceptance is obviously contingent on implementation of the shallow aquifer remedies. There is also remaining local concern about the need for institution control of deep aquifer use by future development.
Groundwater and Leachate Alternatives	
2. Carbon Adsorption (GW-2)	No negative public comments were received concerning this alternative. The community accepts discharge to Dunstable Brook provided that target levels are attained. The community does not accept on-site disposal of hydroxide precipitation treatment residuals, although the RCRA Subtitle C minimum technology requirements for secure disposal may not be thoroughly understood. Community acceptance might be attained if these requirements were clearly articulated.
3. Air-Stripping (GW-3)	Same as GW-2 above.
4. Biological Treatment (GW-5)	Community acceptance for this alternative is somewhat less than for GW-2 and GW-3 above since biological treatment would generate approximately 15 percent more sludge by weight in addition to the metal hydroxide sludge.
5. Off-Site Treatment (GW-6)	No comments were received on this alternative. The local community would presumable accept off-site treatment and disposal, but it might not accept the increased truck traffic throughout the remedial action that would result. The community would definitely not accept temporary shut downs of the groundwater extraction systems if the disposal to the off-site facility were to be prohibited, due to facility non-compliance, during the remedial action.
Landfill Gas Alternatives	
6. No Action (GAS-1)	The local communities and Route 3 commuters would not accept this alternative because the associated on- and off-site risks and objectionable nuisance odors would remain unmitigated.
7. Gas Flaring (GAS-3)	Community acceptance would be less for this alternative than for the selected incineration alternative because of the lower estimated VOC removal rates.
8. Incineration (GAS-4)	Comments from and discussions with the local community indicate their acceptance with this alternative. Local concerns remain, however, about the need for scrubbers and correct operating temperatures.
9. Combustion Recovery (GAS-5)	The local community would be opposed to the increased air emissions generated by the deep gas well drilling required in this alternative. It would also be opposed to the lower estimated VOC removal rates for gas recovery as compared to incineration and flaring.
Sediment Alternatives	
10. No Action (SED-1)	The local community most likely would not accept this alternative because of the potential for future releases of contaminants to surface water or groundwater.
11. In-Situ Capping (SED-2)	Community acceptance would be less for this alternative than with the excavation alternatives because as a containment option it does not completely remove contaminants from the area and it is projected to be effective for thirty years only. The destruction of aquatic habitat would also be opposed.
12. On-Site Disposal (SED-7)	Some opposition exists against on-site disposal. Non-acceptance would be greater for this alternative than for the following two on-site disposal and treatment alternatives (SED-3 and SED-4).

TABLE 10 (cont.)

EVALUATION OF REMEDIAL ALTERNATIVES BASED ON NINE CRITERIA

ALTERNATIVE	CRITERION 9: COMMUNITY ACCEPTANCE
13. On-Site Solidification and Disposal (SED-3)	Some opposition exists against on-site disposal. Opposition would be less for [illegible]s alternative compared to SED-7 above, however. Opposition could also be less f[illegible] ni than for SED-4 below since SED-4 would produce treated air emissions.
14. On-Site Thermal Aeration and Disposal (SED-4)	Some opposition exists against on-site disposal. Opposition would be less for this alternative compared to SED-7 above since treatment would be involved, but oppositio might be higher for this than for SED-3 above since some treated air emissions would be generated.
15. Off-Site Solidification and Disposal (SED-5)	Community acceptance would be high for this alternative.
16. Off-Site Incineration and Disposal (SED-6)	Community acceptance would be high for this alternative.

TABLE 11

Groundwater Discharge Levels

Contaminant	Discharge Concentration(ug/l)
acetone	250
2-butanone	60
trichloroethene	5
benzene	5
toluene	2000
ethlybenzene	680
xylenes	440
bis (2-ethyl hexyl) phthalate	15
4-methyl-2-pentanone	(monitor only)
benzic acid	(monitor only)
4-methylphenol	(monitor only)
arsenic	50
cadmium	10
chromium	50
iron	300
lead	50
manganese	50
mercury	2
nickel	150
silver	50
sodium	20
zinc	(monitor only)

Other parameters

pH	6.5 -8.0 s.u.
effluent flow	(monitor only -gpd)
biochemical oxygen demand	(monitor only - mg/l
total suspended solids	(monitor only - mg/l)

TABLE
POTENTIAL CHEMICAL-SPECIFIC ARARS AN TERIA, ADVISORIES, AND GUIDANCE
CGL

MEDIA	REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	CONSIDERATION IN THE RI/FS
roundwater				
ederal Regulatory equirements	SDWA - Maximum Contaminant Levels (MCLs) (40 CFR 141.11 - 141.16)	Relevant and Appropriate	MCLs have been promulgated for a number of common organic and inorganic contaminants. These levels regulate the concentration of contaminants in public drinking water supplies, but may also be considered relevant and appropriate for groundwater aquifers used for drinking water.	When risks to public health due to consumption of groundwater were assessed, concentrations of contaminants of concern, including benzene and TCE, were compared to their MCLs. Projected concentrations of benzene exceeded the MCL in several locations. SDWA MCL's also were used in setting discharge requirements.
	RCRA - Maximum Contaminant Limits - (40 CFR 264.94)	Relevant and Appropriate	Standards for 14 toxic compounds have been adopted as part of RCRA groundwater protection standards. These limits are set at MCLs.	Groundwater contaminant levels were compared to these limits. Although eastern shallow groundwater is not a potential drinking water source, it does exceed these limits. Therefore, it requires remediation.
	RCRA - Subpart F Groundwater Protection Standards Alternative Concentration Levels (ACLs)	Relevant and Appropriate	ACLs are one of three possible standards (aside from MCLs and background concentrations) available under Subpart F for setting a clean-up level for remediating groundwater contamination from a RCRA facility.	ACLs may be relevant and appropriate if certain conditions relating to transport and exposure are met. ACLs may need to be determined by EPA. Procedures for developing ACLs are outlined in RCRA Subpart F, Section 264.94.
State Regulatory Requirements Standards (314 CMR 6.00)	DEQE - Massachusetts Groundwater Quality	Applicable	Massachusetts Groundwater Quality Standards have been promulgated for a number of contaminants. When state levels are more stringent than federal levels, the state levels will be used.	DEQE Groundwater Standards were considered when determining discharge levels.
	DEQE - Drinking Water Requirements (310 CMR 22.00)	Relevant and Appropriate		Requirements were considered; however, standards do not apply to contaminants found in CGLRT groundwater.
Federal Criteria, Advisories, and Guidance	SDWA - Maximum Contaminant Level Goals (MCLGs)	To Be Considered	MCLGs are health-based criteria that are to be considered for drinking water sources as a result of SARA. These goals are available for a number of organic and inorganic contaminants.	Projected groundwater concentrations of copper, trans-1,2-dichloroethene, toluene, benzene, and TCE were compared to their MCLGs. For benzene and TCE, MCLGs are set at zero.
	Health Advisories (EPA Office of Drinking Water)	To Be Considered	Health Advisories are estimates of risk due to consumption of contaminated drinking water; they consider noncarcinogenic effects only.	Health advisories were considered for contaminants in groundwater that may be used for drinking water.
	EPA Risk Reference Doses (RfDs)	To Be Considered	RfDs are dose levels developed by EPA for noncarcinogenic effects.	EPA RfDs were used to characterize risks due to exposure to contaminants in groundwater, as well as other media. They were considered for noncarcinogens including toluene, 2-butanone, n-dibutylphthalate, acetone, mercury, and thallium.

TABLE 12 (Continued)
POTENTIAL CHEMICAL-SPECIFIC ARARS AND CRITERIA, ADVISORIES, AND GUIDANCE
CGL

MEDIA	REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	CONSIDERATION IN THE RI/FS
	EPA Carcinogen Assessment Group Potency Factors	To Be Considered	Potency factors are developed by EPA from Health Effects Assessments or evaluation by the Carcinogenic Assessment Group.	EPA Carcinogenic Potency Factors were used to compute the individual incremental cancer risk resulting from exposure to benzene, arsenic, PAHs, trichloroethene, and 1,1-dichloroethene.
	Acceptable Intake - Chronic (AIC) and Subchronic (AIS) - EPA Health Assessment Documents	To Be Considered	AIC and AIS values are developed from RfDs and HEAs for noncarcinogenic compounds.	AIC and AIS values were used to characterize the risks due to several noncarcinogens in various media. These noncarcinogens include cadmium, chromium, copper, and lead.
	EPA Office of Water Guidance - Water-related Fate of 129 Priority Pollutants (1979).	To Be Considered	This guidance manual gives transport and fate information for 129 priority pollutants.	The manual was used to assess the transport and fate of a variety of contaminants.
Massachusetts Criteria, Advisories, and Guidance	Massachusetts Drinking Water Health Advisories	To Be Considered	DEQE Health Advisories are guidance criteria for drinking water.	DEQE Health Advisories were used to develop discharge levels for surface water and groundwater.
Discharge to Publicly Owned Treatment Works				
Federal Regulatory Requirements	RCRA - Pretreatment Standards (40 CFR 403) - GLSD POTW Approved Pretreatment Program Requirements.	Applicable	Discharges to a POTW must comply with the POTW's EPA-approved pretreatment requirements.	POTWs in the area with approved pretreatment programs are being identified and the discharge must be treated to those levels required by the program.
Discharge to Surface Water/Merrimack River				
State Regulatory Requirements	DEQE - Massachusetts Surface Water Quality Standards (310 CMR 4.00)	Applicable	DEQE Surface Water Quality Standards are given for dissolved oxygen, temperature increase, pH, and total coliform and there is a narrative requirement for toxicants in toxic amounts. In the absence of a numeric state standard for a compound, federal AWQC would be appropriate.	Requirements were considered; however, no numerical standards exist for contaminants found in CGLRT groundwater which would be discharged to surface water. Federal AWQC will be used in the absence of narrative standards.

TAB[illegible] (Continued)
POTENTIAL CHEMICAL-SPECIFIC AR[illegible] AND CRITERIA, ADVISORIES, AND GUIDANCE
CGL

MEDIA	REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	CONSIDERATION IN THE RI/FS
Federal Criteria, Advisories, and Guidance	Federal Ambient Water Quality Criteria (AWQC)	Applicable	Federal AWQC are health-based and environmentally based criteria which have been developed for 95 carcinogenic and noncarcinogenic compounds.	AWQC were considered in characterizing public health risks to aquatic organisms due to contaminant concentrations in surface water at Flint Pond. Because this water is not used as a drinking water source, the criteria developed for aquatic organism protection and ingestion of contaminant aquatic organisms were considered. AWQC were also used for setting limits for discharge to the Merrimack River.
Air				
Federal Regulatory Requirements	CAA - National Ambient Air Quality Standards (NAAQS) - 40 CFR 40.	Relevant and Appropriate	These standards were primarily developed to regulate stack and automobile emissions.	Standards for sulfur dioxide, carbon monoxide and nitrogen dioxide will be complied with.
State Regulatory Requirements	DEQE - Air Quality, Air Pollution (310 CMR 6.00 - 8.00).	Relevant and Appropriate	These standards were primarily developed to regulate stack and automobile emissions.	
Federal Criteria, Advisories, and Guidance	Threshold Limit Values (TLVs)	To Be Considered	These standards were issued as consensus standards for controlling air quality in workplace environments.	TLVs could be used for assessing site inhalation risks for soil removal operations.
Massachusetts Criteria, Advisories, and Guidance	Massachusetts Guidance on Acceptable Ambient Air Levels (AALs)	To Be Considered	These are guidelines in discharge permit writing.	AALs were considered when assessing the significance of monitored and modeled residential contamination.

TABLE 13
POTENTIAL LOCATION-SPECIFIC ARARS AND CRITERIA, ADVISORIES, AND GUIDANCE
CGL

SITE FEATURE	REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	CONSIDERATION IN THE RI/FS
Wetlands				
Federal Regulatory Requirements	Clean Water Act (CWA) - 40 CFR Part 230	Applicable	Under this requirement, no activity that adversely affects a wetlands shall be permitted if a practicable alternative that has less effect is available.	During the identification, screening, and evaluation of alternatives, the effects on wetlands are evaluated.
	Fish and Wildlife Coordination Act (16 U.S.C 661)	Applicable	This regulation requires that any federal agency proposing to modify a body of water must consult with the U.S. Fish and Wildlife Services. This requirement is addressed under CWA Section 404 requirements.	Requirement addressed under CWA Section 404.
State Regulatory Requirements	DEQE - Wetlands Protection (310 CMR 10.00)	Applicable	These regulations are promulgated under Wetlands Protection Laws, which regulate dredging, filling, altering, or polluting inland wetlands. Work within 100 feet of a wetland is regulated under this requirement. The requirement also defines wetlands based on vegetation type and requires that effects on wetlands be mitigated.	If alternatives require that work be completed within 100 feet of a DEQE-defined wetland, these regulations will be considered. Mitigation of impacts on wetlands will be addressed under CWA 404.
	Hazardous Waste Facility Siting Regulations (990 CMR 1.00)	Relevant and Appropriate	These regulations outline the criteria for the construction, operation, and maintenance of a new facility or increase in an existing facility for the storage, treatment, or disposal of hazardous waste. Specifically, no portion of the site may be located within a wetland or bordering a vegetated wetland.	These regulations will be addressed during the design phase of the treatment facility construction.
Federal Nonregulatory Requirements to be Considered	Wetlands Executive Order (EO 11990)	To Be Considered	Under this regulation, federal agencies are required to minimize the destruction, loss, or degradation of wetlands, and preserve and enhance natural and beneficial values of wetlands.	Many of the requirements of this EO will be addressed under CWA Section 404. Any remaining requirements will also be considered during the identification, screening, and evaluation of alternatives.

TAB. (Continued)
POTENTIAL LOCATION-SPECIFIC ARARS AND CRITERIA, ADVISORIES, AND GUIDANCE
COL

SITE FEATURE	REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	CONSIDERATION IN THE RI/FS
Landfill and Leachate Ponds				
Federal Regulatory Requirements	RCRA - Standards for Owners and Operators of Permitted Hazardous Waste Facilities (40 CFR 264.10-264.18)	Relevant and Appropriate	General facility requirements outline waste analysis, security measures, and training requirements.	Treatment residuals from the wastewater treatment facility will be disposed according to RCRA Subtitle C.
	RCRA - Preparedness and Prevention (40 CFR 264.30-264.37)	Relevant and Appropriate	This regulation outlines safety equipment and spill control requirements for hazardous waste facilities. Part of the regulation includes a requirement that facilities be designed, maintained, constructed, and operated so that the possibility of an unplanned release which could threaten public health or the environment is minimized.	RCRA requirements must be considered when evaluating extensions to the present landfill.
	RCRA - Contingency Plan and Emergency Procedures (40 CFR 264.50-264.56)	Relevant and Appropriate	This regulation outlines requirements for emergency procedures to be used following explosions and fires. This regulation also requires that threats to public health and the environment be minimized.	RCRA requirements must be considered when evaluating extensions to the present landfill.
	RCRA - Groundwater Protection (40 CFR 264.90-264.109)	Relevant and Appropriate	Under this regulation, groundwater monitoring program requirements are outlined.	A groundwater monitoring system must be installed as part of any alternative. During site characterization, the location and depth of monitoring wells will be evaluated for use in this monitoring program.
	RCRA - Closure and Post-closure (40 CFR 264.110-264.120)	Relevant and Appropriate	This requirement details the specific requirements for closure and post-closure of hazardous waste facilities.	A post-closure plan is currently being developed for the site by EPA.
State Regulatory Requirements	DEQE - Hazardous Waste Regulations, Phase I and II	Relevant and Appropriate	These regulations provide a comprehensive program for the handling, storage, and recordkeeping at hazardous waste facilities. They supplement RCRA regulations.	Because these requirements supplement RCRA hazardous waste regulations, they must also be considered at the CGLRT site.

TABLE 14
POTENTIAL ACTION-SPECIFIC ARARs
CGL

ARARS	REQUIREMENT SYNOPSIS	ACTION TO BE TAKEN TO ATTAIN ARARS (IF NECESSARY)
RCRA - Standards for Owners and Operators of Permitted Hazardous Waste Facilities (40 CFR 244.10 - (264.8)	General facility requirements outline general waste analysis, security measures, inspections, and training requirements.	All facilities on-site will be constructed, fenced, posted, and operated in accordance with this requirement. All workers will be properly trained. Process wastes will be evaluated for the characteristics of hazardous wastes to assess further landing requirements.
RCRA - Preparedness and Prevention (40 CFR 264.30 - 264.31)	This regulation outlines requirements for safety equipment and spill control.	Safety and communication equipment will be installed at the site; local authorities will be familiarized with site operations.
RCRA - Contingency Plan and Emergency Procedures (40 CFR 264.50 - 254.56)	This regulation outlines the requirements for emergency procedures to be used following explosions, fires, etc.	Plans will be developed and implemented during site work including installation of monitoring wells, and implementation of site remedies. Copies of the plans will be kept on-site.
RCRA - Manifesting, Recordkeeping, and Reporting (40 CFR 264.70 - 264.77)	This regulation specifies the recordkeeping and reporting requirements for RCRA facilities.	Records of facility activities will be developed and maintained during remedial actions.
RCRA - Groundwater Protection (40 CFR 264.90 - 264.109)	This regulation details requirements for a groundwater monitoring program to be installed at the site.	A groundwater monitoring program is a component of all alternatives. RCRA regulations will be considered during development of this program.
RCRA - Closure and Post-closure (40 CFR 264.110 - 264.120)	This regulation details specific requirements for closure and post-closure of hazardous waste facilities.	Those parts of the regulation concerned with long-term monitoring and maintenance of the site will be considered during remedial design.
OSHA - General Industry Standards (29 CFR Part 1910)	This regulation specifies the 8-hour time-weighted average concentration for various organic compounds.	Proper respiratory equipment will be worn if it is impossible to maintain the work atmosphere below the concentrations.
OSHA - Safety and Health Standards (29 CFR Part 1926)	This regulation specifies the type of safety equipment and procedures to be followed during site remediation.	All appropriate safety equipment will be on-site. In addition, safety procedures will be followed during on-site activities.
OSHA - Recordkeeping, Reporting, and Related Regulations (29 CFR 1904)	This regulation outlines the recordkeeping and reporting requirements for an employer under OSHA.	These requirements apply to all site contractors and subcontractors and must be followed during all site work.
RCRA - 40 CFR 268 EPA Regulations on Land Disposal Restrictions	This regulation outlines land disposal requirements and restrictions for hazardous wastes.	Regulations to be phased in over the next few years require contaminated soils to be treated to the Best Demonstrated Available Technology levels before being placed or replaced on the land. Hazardous waste cannot be stored except when accumulated for recovery, treatment, or disposal. Land disposal restrictions for PAH's have not yet been developed.

TABLE 14 (con't)
POTENTIAL ACTION-SPECIFIC ARARs
CGL

ARARs	Requirement Synopsis	Action to be Taken to Attain ARARs
CWA - 40 CFR Parts 122, 125	Any point source discharges must meet NPDES permitting requirements, which include compliance with applicable water quality standards; establishment of a discharge monitoring system; and routine completion of discharge monitoring records.	If groundwater that has been treated by on-site treatment processes is discharged to surface waters on-site, treated groundwater must be in compliance with applicable water quality standards. In addition, a discharge monitoring program must be implemented. Routine discharge monitoring records must be completed.
CWA - 40 CFR Part 403	This regulation specifies pretreatment standards for discharges to a POTW.	If a leachate collection system is installed and the discharge is sent to a POTW, the POTW must have an approved pretreatment program. The collected leachate runoff must be in compliance with the approved program. Prior to discharging, a report must be submitted containing identifying information, list of approved permits, description of operations, flow measurements, measurement of pollutants, certification by a qualified professional, and a compliance schedule.
CWA - 40 CFR Part 230	This regulation outlines requirements for discharges of dredged or fill material. Under this requirement, no activity that impacts a wetland will be permitted if a practicable alternative that has less impact on the wetland is available. If there is no other practicable alternative, impacts must be mitigated.	During the identification, screening, and evaluation of alternatives, the effects on wetlands must be evaluated.
CAA - NAAQS for Total Suspended Particulates (40 CFR 129.105,750)	This regulation specifies maximum primary and secondary 24-hour concentrations for particulate matter.	Fugitive dust emissions from site excavation activities will be maintained below 260 $\mu g/m^3$ (primary standard) by dust suppressants, if necessary.
Protection of Archeological Resources (32 CFR Part 229,229.4; 43 CFR Parts 107, 171.1-171.5)	This regulation develops procedures for the protection of archeological resources.	If archeological resources are encountered during soil excavation, work will stop until the area has been reviewed by federal and state archaeologists.
DOT Rules for Transportation of Hazardous Materials (49 CFR Parts 107, 171.1-171.5)	This regulation outlines procedures for the packaging, labeling, manifesting, and transportation of hazardous materials.	Contaminated materials will be packaged, manifested, and transported to a licensed off-site disposal facility in compliance with these regulations.
DEQE - Hazardous Waste Regulations, Phase I and II. (310 CMR 30.000, MGL Ch. 21C)	This regulation provides a comprehensive program for the handling, storage, and recordkeeping at hazardous waste facilities. They supplement RCRA regulations.	Because these requirements supplement RCRA hazardous waste regulations, they must also be considered at the CGLRT site.
General Laws Ch. 111, Sec. 150B	Under this regulation, the local board of health may require a local site assignment for hazardous waste treatment, storage, and/or disposal facilities.	The local board of health should be made aware of any hazardous waste activities.

TABLE 14 (con't)
POTENTIAL ACTION-SPECIFIC ARARs
CGLRT FS

ARARs	Requirement Synopsis	Action to be Taken to Attain ARARs
Acts of 1982, Ch. 232, Sec. 150A and 150B	This regulation requires that notice be recorded in the Registry of Deeds whenever certain types of solid or hazardous waste activity occur on property.	Notification of remedial actions will be given to th County Registry of Deeds.
DEQE - Air Quality, Air Pollution (310 CMR 6.00 - 8.00)	This regulation outlines the standards and requirements for air pollution control in the State of Massachusetts; all provisions, procedures, and definitions are described.	Particulate matter emissions from site excavation activities must be maintained at an annual geometric mean of 75 $\mu g/m^3$, and a maximum 24-hour concentration of 40 mg/m^3 (primary standards).
DEQE - Wetlands Protection (310 CMR 10.00)	This regulation outlines the requirements necessary to work within 100 feet of a coastal or inland wetland. The act sets forth a public review and decision-making process by which activities affecting waters of the state are to be regulated to contribute to their protection.	Wetland remediation will comply with the substantive but not the administrative requirements for wetland protection.
MDWPC - Massachusetts Surface Water Discharge Permit Program (314 CMR 1.00-7.00)	This section outlines the requirements for obtaining an NPDES permit in Massachusetts.	Pollutant discharges to surface water or groundwater must comply with NPDES permit requirements. Permit conditions and standards for different classes of water are specified.
MDWPC - Supplemental Requirements for Hazardous Waste Management Facilities (314 CMR 8.00)	This regulation outlines the additional requirements that must be satisfied in order for a RCRA facility to comply with the NPDES regulations. These regulations apply to a water treatment unit; a surface impoundment that treats influent wastewater; and a POTW that generates, accumulates, and treats hazardous waste.	All owners and operators of RCRA facilities shall comply with the management standard of 310 CMR 30.500, the technical standards of 310 CMR 30.600, the location standards of 310 CMR 30.700, the financial responsibility requirements of 310 CMR 30.900 and, in the case of POTWs, the standards for generators in 310 CRM 30.300.
Waterways Regulations (314 CMR 9.00 MGL Ch. 91)	This regulation is promulgated to establish procedures, criteria, and standards for the water quality certification of dredging and dredged material disposal.	Applications for proposed dredging/fill work need to be submitted and approved before work commences. Three categories have been established for dredge or fill material based on the chemical constituents. Approved methods for dredging, handling, and disposal options for the three categories must be met.
Operation and Maintenance and Pretreatment Standards for Wastewater, Treatment Works, and Indirect Discharges (314 CMR 12.00)	The regulations establish requirements that ensure the proper operation and maintenance of wastewater facilities within the Commonwealth.	A wastewater treatment facility would be operated and maintained in compliance with this regulation.
Implementation of M.G.L. C.111F, Employee and Community "Right to Know" (310 CMR 33.00)	The regulations establish rules and requirements for the dissemination of information related to toxic and hazardous substances to the public.	Information applicable to site activities and characteristics will b made available to the public.
Worker "Right to Know" (441 CMR 21.00)	These regulations establish requirements for worker "Right to Know."	These requirements apply to all site workers and must be followed during all site work.

TABLE 15
COST SUMMARY FOR SELECTED REMEDY
CGL

Capital Costs:

Landfill Gas Incineration	$ 959,000
Groundwater Extraction System	878,000
Groundwater Treatment System	2,089,000
Sediment Removal, Treatment, and Disposal	79,000
Discharge to Dunstable Brook	26,000
Total Capital Costs	$ 4,031,000

Operation and Maintenance Costs:

Landfill Gas Incineration	$ 8,000/yr
Groundwater Extraction System	42,000/yr
Groundwater Treatment System	552,000/yr
Groundwater Monitoring System	138,000/yr
Discharge System	33,000/yr
Total Annual Operation and Maintenance Costs	$ 773,000/yr

Total Present Worth* (with costs for discharge to Dunstable Brook)	$11,320,000

*10% interest, 30 year pw factor = 9.427

APPENDIX A

EBASCO SERVICES INCORPORATED

EBASCO

211 Congress Street 8th Floor Boston MA 02110-2410 (617) 451-1201

September 29, 1988
REM-RMI-88-556

Ms. Kathleen James
Community Relations Coordinator
U.S. Environmental Protection Agency
Region I
John F. Kennedy Federal Building
Boston, MA 02203

Subject: REM III - EPA CONTRACT NO. 68-01-72
WORK ASSIGNMENT NO. 60-1L16
CHARLES GEORGE LANDFILL RECLAMATION TRUST
SUPERFUND SITE
FINAL RESPONSIVENESS SUMMARY

Dear Ms. James:

Ebasco Services, Incorporated is pleased to submit this Final Responsiveness Summary of comments and EPA responses to public comment received on the Feasibility Study and Proposed Plan for the Charles George Landfill Reclamation Trust site in Tyngsborough, Massachusetts.

If you have any comments or questions regarding this submittal, please call Russell H. Boyd at (617) 451-1201 or Richard Quateman at (617) 723-3860.

Sincerely,

Russell H. Boyd, Jr., P.E.
Ebasco Services Inc.
REM III Regional Manager
Region I

RHB/RG/es

CC: N. Barmakian (w/o encl.)
D. Dickerson
M. Amdurer
J. McAdoo
G. Vaillancourt
FILE: CHAR

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REM III PROGRAM

REMEDIAL PLANNING ACTIVITIES AT SELECTED UNCONTROLLED HAZARDOUS SUBSTANCE DISPOSAL SITES WITHIN EPA REGIONS I-IV

FINAL RESPONSIVENESS SUMMARY
CHARLES GEORGE RECLAMATION TRUST LANDFILL SITE
TYNGSBOROUGH, MASSACHUSETTS

SEPTEMBER 28, 1988

Prepared By:	Approved By:
R.K. Quateman	
Richard K. Quateman Community Relations Specialist REM III/ICF Incorporated	Russell H. Boyd, Jr., P.E. REM III Regional Manager Region I Ebasco Services, Inc.

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Preface

The U.S. Environmental Protection Agency (EPA) held a public comment period from August 4, 1988 to August 24, 1988 to provide an opportunity for interested parties to comment on the July 1988 Phase III Feasibility Study (FS) and the Proposed Plan prepared for the Charles George Reclamation Trust Landfill (Charles George) Superfund site in Tyngsborough, Massachusetts. The Phase III FS examines and evaluates various options, called remedial alternatives, for addressing landfill gas emissions, leachate and groundwater contamination, and contamination of sediments in Dunstable Brook. EPA identified its preferred alternative for the cleanup of the site in the Proposed Plan issued on July 21, 1988 before the start of the public comment period.

The purpose of this responsiveness summary is to document EPA responses to the comments and questions raised during the public comment period. EPA will consider all of the comments summarized in this document before selecting a final remedial alternative for the contamination at the Charles George Reclamation Landfill Trust Superfund site in Tyngsborough, Massachusetts.

This responsiveness summary is divided into the following sections:

I. Overview of Remedial Alternatives Considered in the Feasibility Study and Proposed Plan - This section briefly outlines the remedial alternatives evaluated in the FS and Proposed Plan, including the preferred alternative: biological treatment, metals precipitation, carbon adsorption, and ion exchange for shallow groundwater and leachate; deep bedrock groundwater and residential well monitoring; incineration for landfill vent emissions; and, excavation, on-site solidification and disposal of contaminated sediments.

II. Background on Community Involvement and Concerns - This section provides a brief history of community interests and concerns regarding the Charles George Landfill site.

III. Summary of Comments Received During the Public Comment Period and EPA Responses to These Comments - This section summarizes, and provides EPA responses to the comments received from the public and other interested parties during the public comment period. These comments are organized by subject area. In addition, comments received from the Potentially Responsible Parties are summarized along with EPA's responses.

IV. Remaining Concerns - This section describes issues that may continue to be of concern to the community during the design and implementation of EPA's selected remedy for the Charles George Landfill site. EPA will address these concerns during the Remedial Design and Remedial Action (RD/RA) phase of the cleanup process.

Attachment A - This attachment provides a list of the community relations activities that EPA has conducted to date at the Charles George Landfill site.

Attachment B - Transcript of the August 17, 1988 Informal Public Hearing held in Tyngsborough, Massachusetts.

I. OVERVIEW OF REMEDIAL ALTERNATIVES CONSIDERED IN THE FEASIBILITY STUDY AND PROPOSED PLAN

Using the information gathered during the Phase III Remedial Investigation (RI) — a study that investigates the nature and extent of contamination at the site — and Risk Assessment — a study that assesses the potential risks to human health and the environment associated with the site contamination — EPA identified several objectives for the cleanup of the Charles George site. (See Figure 1 for a map of the Charles George site.) The objectives are:

(1) Reduce potential risks posed by contact with contaminated sediments in Dunstable Brook and the tributary originating at the landfill;

(2) Reduce potential health risks posed by drinking contaminated groundwater near the site;

(3) Reduce public health risks posed by breathing landfill gas emissions;

(4) treat or dispose of landfill leachate as required by EPA's Phase II 1985 Record of Decision.

After identifying the cleanup objectives, EPA developed and evaluated potential cleanup alternatives. The Phase III FS report describes the alternatives considered for addressing contamination of groundwater and leachate, landfill gases, and sediments, as well as the criteria EPA used to narrow the list to sixteen potential remedial alternatives. Three of these alternatives were chosen by EPA as the combined preferred alternative to address the different aspects of site contamination.

Each of the sixteen alternatives is described briefly below. The July 1988 Proposed Plan should be consulted for detailed explanations of the preferred alternative.

Alternatives Evaluated for Treatment of Groundwater and Landfill Leachate

1. No Action. The no-action alternative would involve long-term monitoring of shallow and deep groundwater with a review of site conditions every five years to determine if additional cleanup activities were necessary. While groundwater would not be treated, a separate leachate treatment program would be instituted.

2. Extraction, Biological Treatment and Discharge (EPA's Preferred Alternative). Contaminated groundwater in soil and shallow bedrock from the southwestern and eastern area of the landfill will be collected with a system of wells and a groundwater collection trench; landfill leachate will be collected via a separate system. The groundwater and leachate will be combined and treated using naturally occurring microorganisms to break down organic compounds. The treated water will then be passed through metal precipitation units and carbon adsorption units to remove additional inorganic and organic contaminants. As part of the treatment process, sludge will be generated. EPA plans call for placement of the sludge in an extension to the

landfill, if feasible. If this is not determined to be feasible, the sludge would be placed in a federally approved hazardous waste facility. A pilot test of the leachate and groundwater treatment system will be conducted prior to full scale implementation of the cleanup.

3. Extraction, Carbon Adsorption, and Discharge. This alternative would utilize the same extraction and treatment system as the preferred alternative, except that it would include extraction of eastern deep bedrock groundwater and it would not include biological treatment. Treated water would be discharged to Dunstable Brook, the Merrimack River, or reinjected into groundwater.

4. Extraction, Air Stripping, and Discharge. This alternative is similar to the above alternative, except that air stripping would be added to the treatment process. Air stripping involves pumping the groundwater into a vertical column through which air is forced to remove, or strip, volatile organic compounds (VOCs) from the water.

5. Extraction, Off-site Treatment, and Discharge. In this alternative, groundwater and leachate would be collected and trucked off site to an EPA-permitted hazardous waste treatment facility.

Alternatives Evaluated for Treatment of Landfill Gas Emissions

6. No Action. In this alternative, landfill gas emissions would be discharged to the atmosphere without treatment.

7. On-site Incineration (EPA's Preferred Alternative). In this alternative, landfill gases will be collected with a series of gas vents and piped to an on-site incinerator where the contaminants are destroyed at a temperature of greater than 1200 degrees Fahrenheit. After start-up, the incinerator will be fueled by the methane present in the vent emissions.

8. Gas Flaring. In this alternative, landfill gas emissions would be treated to remove acidic compounds and then burned in an on-site gas flaring unit.

9. Combustion/Medium Btu Gas Recovery. In this alternative, landfill gases would be collected through a combination of the vent system and a series of deep gas wells throughout the landfill. The collected gases would be piped to an internal combustion engine that would burn the gas to produce electricity.

Alternatives Evaluated for Treatment of Sediments

10. No Action. In this alternative, the contaminated sediments would be left in place in Dunstable Brook and a tributary to the brook. EPA would review site conditions every five years to determine if remedial actions are necessary.

11. Removal, On-site Solidification, and Disposal of Contaminated Brook Sediments (EPA's Preferred Alternative). Contaminated sediments in Dunstable Brook and a tributary to the brook will be excavated, combined with a solidifying material such as Portland cement to stabilize the contaminants, and disposed on-site under the landfill cap.

12. On-site Capping. This alternative would involve covering, or capping, sediments in the brook and tributary with a synthetic fabric and four-to-six inches of crushed stone.

13. Excavation, Thermal Aeration, and Disposal. This alternative would require excavation of contaminated sediments followed by thermal treatment in which hot air would be forced through sediments to remove VOCs. Air emissions would be treated prior to release to the atmosphere, and treated sediments would be placed on the landfill for capping.

14. Excavation, Off-site Solidification, and Disposal. In this alternative, contaminated sediments would be excavated and shipped off-site to an approved hazardous waste treatment facility for solidification and disposal.

15. Excavation, Incineration, and Disposal. In this alternative, contaminated sediments would be excavated and shipped off-site to an approved hazardous waste incineration facility where the contaminants would be destroyed at high temperatures.

16. Excavation and On-site Disposal. This alternative would entail excavating contaminated sediments and placing them in the landfill. The sediments would be contained by the landfill cap once it is completed.

II. BACKGROUND ON COMMUNITY INVOLVEMENT AND CONCERNS

The Charles George Landfill site is a 70-acre municipal and industrial waste landfill located approximately one mile southwest of the town of Tyngsborough, Massachusetts. A portion of the site is also located in neighboring Dunstable, Massachusetts. A 96 unit condominium complex is located within 800 feet of the site. In addition to municipal and industrial waste, the landfill owners accepted hazardous waste from 1973 through at least 1976. EPA involvement in the site began in 1981 with a field investigation of groundwater contamination. Local residents have been very active in landfill-related issues for over a decade. Initial concerns focused on dust and noise associated with the landfill operation, and later turned to concerns over the hazardous wastes disposed of at the site. On two separate occasions Tyngsborough residents formally voiced their opposition to the operations of the landfill. A formal condominium owners association focusing on groundwater pollution concerns was formed in the early 1980's, and a separate neighborhood association concerned with contamination of Flint Pond and Marsh also developed. A formal citizens advisory committee (CAC) was formed in March 1987. EPA representatives regularly meet with the CAC to discuss issues of community concern surrounding the landfill and the results of on-going EPA investigations.

The principal community concerns are summarized below:

Phase I Waterline Installation

Citizens expressed concern about the time it is taking for EPA to connect a permanent waterline to the condominium complex.

Groundwater Treatment

Residents expressed concern about the amount of sludge that would be generated by the groundwater and leachate treatment plant, and stressed their apprehension over EPA's plans for on-site disposal of the sludge.

Flint Pond and Marsh

Residents expressed strong concerns about the possible contamination of Flint Pond, noting that area children regularly use the pond for swimming.

III. SUMMARY OF COMMENTS RECEIVED DURING THE PUBLIC COMMENT PERIOD AND EPA RESPONSES

This responsiveness summary addresses the comments received by EPA concerning the draft FS and Phase III Proposed Plan for the Charles George Landfill Superfund site in Tyngsborough, Massachusetts. Five sets of written comments were received during the public comment period (August 4 - August 24, 1988): One from the Town of Tyngsborough Conservation Commission, two sets from the Potentially Responsible Parties, and two letters from concerned citizens. In addition, the EPA Project Manager answered informal questions from the public. Copies of the transcript of the August 17, 1988 informal public hearing are available at the Tyngsborough Board of Health, Tyngsborough Town Hall, 10 Kendall Road; Littlefield Public Library, 252 Middlesex Road; and, the EPA Records Center at 90 Canal Street, First Floor, in Boston, Massachusetts.

A. Summary of Citizen and Other Interested Party Comments

These comments, along with EPA responses, are summarized and organized into the following categories:

1. The Phase I Record of Decision (ROD): Waterline Installation
2. The Phase II ROD: Landfill Cap
3. The Phase III Proposed Plan
4. Future Use of the Site
5. Site Information

1. Comments Concerning the Phase I ROD: Waterline Installation

Comment 1. A town official stated that the Flint Pond area has received intermittent contamination from landfill leachate and that the wells in the area should therefore be considered threatened. The commenter further stated that EPA should amend the Phase I ROD to provide users of these wells with municipal water.

EPA Response: Remedial Investigation (RI) data do not provide absolute proof that contaminant sources other than the Charles George Landfill are responsible for low contaminant concentrations in Flint Pond area wells. However, the following three findings based on RI data suggest that contamination in these wells was not derived from the Charles George site.

1. Existing hydraulic data do not indicate that groundwater is moving in the northeastward direction from the site to these wells. The actual

flowpath appears to be approximately 45 degrees off course. Two factors could cause the plume to deviate to the north. First, the Town of Tyngsborough may be pumping enough deep groundwater to create hydraulic gradients in this direction. Second, conductive bedrock fractures could run in the northeast direction under Flint Pond. If these two conditions exist, Flint Pond well contamination could be due to Charles George contamination. Charles George contaminants would not reach these wells in detectable levels via transport through Flint Pond or shallow groundwater in glacial sediments.

2. Unless the Town of Tyngsborough has been pumping a large quantity (greater than 100 gallons per minute [gpm]) of deep bedrock groundwater for many years, contamination from the Charles George site has not had sufficient time to reach Flint Pond area wells (based on measured gradients).

3. Because none of the wells have shown consistent levels of contamination, there is no conclusive evidence of a plume in the Flint Pond area. Also, the one-time flow levels of several compounds do not suggest a conductive fracture or a correlation with well depth. Contaminants identical to those found in landfill groundwater have not been detected more than once in any individual well in the Flint Pond area.

EPA plans to continue the residential well monitoring program as well as additional groundwater monitoring to provide continuing data on the potential for groundwater contamination from the landfill to impact the Flint Pond residential area. Appropriate remedial action, possibly including an extension to the waterline, will be implemented if a contaminant plume exhibiting unacceptable human health risks is discovered.

2. Comments Concerning the Phase II ROD: Landfill Cap

Comment 2. A town official noted that little information is available on the long-term durability of synthetic caps for an area as large as the Charles George Landfill. The commenter requested that EPA institute a monitoring and maintenance program to ensure the continuing integrity of the cap.

EPA Response: The integrity of the cap will be monitored and maintained as part of the post-closure activities for the landfill. These activities will include nearby groundwater monitoring and visual inspection of the liner material via the 20 inspection ports designed into the cap. Continued surveying of the landfill is also being done to monitor landfill settlement and to analyze potential impacts on liner integrity. All post-closure activities including appropriate responses to potential problems are presently being finalized in a Post-closure Plan.

Comment 3. A number of citizens expressed concern over potential erosion during cap construction and urged EPA to implement an effective erosion control program.

EPA Response: The specifications for the cap project include a requirement for complete perimeter erosion control using stacked hay bales or pre-assembled silt fence structures. The specifications also require the construction contractor to submit an erosion control plan for EPA review and approval. For further information, see Section 02150 of the landfill cap specifications.

Comment 4. A town official questioned if EPA plans to disturb the landfill cap after it is constructed in order to install the leachate treatment and vent collection systems. The commenter expressed concern over the timing of the operation.

EPA Response: The landfill liner will not be disturbed by construction of either the leachate treatment system, the vent emission collection system, or the incinerator. The collection systems for both the leachate and the landfill gas will be installed as part of the cap project. The upcoming Phase III remedy will implement the cleanup by installing and connecting the on site treatment systems to the collection systems.

3. Comments Regarding the Phase III Proposed Plan

Comment 5. A Town official stated that all sludge from the water treatment plant and all sediments excavated from Dunstable Brook should be disposed of off site.

EPA Response: Sludge from the leachate and groundwater treatment system will be disposed on site only if it is found to be a feasible option for disposal according to the requirements of Subtitle C of the Resource Conservation and Recovery Act (RCRA) for secure disposal of hazardous waste. These requirements include the installation of two or more liners with leachate collection systems above and between each liner. The treatment plant sludge will be dewatered and should not release contaminants. The sludge also will have a sufficiently high pH so that metals are rendered insoluble and will, therefore, not easily be released. If it is determined that construction of a secure extension of the landfill is not feasible, the sludge will be disposed in an off-site facility.

Disposal of Dunstable Brook sediments under the landfill cap will significantly reduce the mobility of the polynuclear aromatic hydrocarbons (PAH) sediment contaminants. Solidification of the sediments will further reduce their mobility. Sediments with higher PAH contamination are being similarly managed on site by using the designated spoil disposal area of the capping project. The incremental contamination and associated risks from Dunstable Brook sediments will be negligible.

Comment 6. One commenter urged EPA to install air pollution control devices on the vent gas incinerator.

EPA Response: Air pollution devices will be installed on the incinerator if air sampling indicates that permissible air quality standards are exceeded. Continuous air monitoring equipment will be installed to measure carbon monoxide, oxygen, and total hydrocarbons in the stack emissions, and downstream, on-site plume sampling will be done to monitor sulfur dioxide, nitrogen dioxide, carbon monoxide, and volatile organic compounds (VOCs).

Comment 7. A Town official expressed concern over the quality and timeliness of the data collected in the Phase III RI. The commenter questioned the lack of current data on water quality in residential wells and the impact of "laboratory contamination" of site samples.

EPA Response: Concerning the air investigation of the RI, the dual objectives of the air monitoring and modeling were to (a) establish the nature of any risks posed to public health or the environment under the current, uncapped condition of the landfill, and (b) predict the nature of risks posed under the future capped, vented condition of the landfill. The air study established that off-site risks due to gaseous emissions were low under both current and future conditions, exceeding EPA's target risk range only under worst-case conditions. Most significantly, however, results of the air study indicate that on-site risks due to potential exposure under either current or future scenarios would be at levels considered unacceptable to EPA. As a result, the remedial alternative selected will include incineration of vented landfill emissions. This action will reduce future on-site risks to a level considered acceptable, and will reduce off-site risks to levels significantly below those currently existing.

Concerning the residential well data, recent sampling done by EPA supports the conclusions discussed in the RI and in this responsiveness summary. The results of this sampling and all future sampling will be included into a database and made available to the public. "Laboratory contamination" usually refers to the detection of low parts per billion concentrations of cleaning solvents, but can also include similarly low levels of phthalates dissolved from plastic or rubber sampling equipment. These low levels do not interfere with the detection of other contaminants.

Comment 8. A Town official reminded EPA that any off site remediation activities that affect wetlands must be conducted in accordance with State and local wetland regulations. The commenter expressed the willingness of the Town to work with EPA to find solutions that will allow EPA to conduct the cleanup.

EPA Response: Excavation of Dunstable Brook sediments will conform to all the substantive requirements of Federal, State, and local wetland protection requirements. Impacts will be minimized by using silt curtains and oil booms, and by restoring the impacted wetland area to its original condition.

4. Future Site Use

Comment 9. A number of citizens asked what EPA would do to prevent inappropriate future development of the Charles George site. Citizens stated that a ban on new wells that could tap the contaminated deep aquifer should be instituted.

EPA Response: As discussed in the Phase III ROD, implementation of institutional controls over deep bedrock groundwater use would increase the protectiveness of the remedy. EPA will work with the State and Town in developing appropriate zoning or deed controls, and in evaluating development proposals involving large-yield pumping.

5. Site Information

Comment 10. A town official stated that EPA has not made site information available to the public in a timely fashion, and also noted that the Town Hall information repository lacked documents.

EPA Response: EPA made the RI, FS and Proposed Plan available to the public as soon as possible. The FS and Proposed Plan were sent out well in advance of the public comment period to provide time for review. The RI was made available as soon as it had been finalized. All documents were hand delivered or express mailed to the two local information repositories, The Tyngsborough Board of Health at the Tyngsborough Town Hall and the Littlefield Public Library, before the start of the comment period. Apparently, for reasons unknown to the Agency, Volume II of the RI was not available at the Town Hall by the start of the comment period, although it had been express mailed on August 1, 1988. Volume II was available at the Littlefield Public Library, however, since it was also express mailed on August 1. Volume II was made available at the Town Hall, along with another complete set of documents for the Town Clerk, on August 22, 1988.

B. Summary of Potentially Responsible Parties (PRP) Comments

Comments received from the PRPs, and EPA's responses are summarized in the following section.

Comment 1. The PRPs support and encourage EPA's plans to conduct pilot and pre-design studies of the leachate and groundwater treatment technologies. Pilot testing of the vent gas incineration system is also suggested.

EPA Response: Pilot testing of other gas treatment systems before completion of the landfill cap and gas collection system is impracticable, and the delays that would be caused by pilot testing are unacceptable. Once the incineration system is implemented, however, safe pilot-testing of other treatment systems could conceivably be done by routing vent gases through the pilot plant, and then routing pilot-plant effluent gases to the incinerator. Auxiliary fuel would most likely be needed for the incinerator if pilot testing were done in this manner.

Comment 2. Shallow groundwater contamination should be further evaluated to determine if treatment is actually required to protect public health and the environment. Naturally occurring levels of arsenic should be determined.

EPA Response: EPA acknowledges that the eastern overburden aquifer could meet the target levels established in the Phase III ROD before the other contaminated aquifers. As described in the ROD, treatment of this aquifer is only required if target levels are exceeded. A two-stage extraction system in the eastern area could be advantageous and will be investigated during remedial design. If found to be feasible, it will then be implemented. Arsenic concentrations in uncontaminated groundwater around the landfill will be further evaluated as a result of the post-closure groundwater monitoring, and these results will be given appropriate consideration in evaluating whether the arsenic target level should be readjusted. It should be noted, however, that during the 1987 Remedial Investigation, arsenic was detected in the contaminated southwestern and eastern plumes (including the shallow eastern plume) only.

Comment 3. EPA should investigate the feasibility and cost-effectiveness of treating landfill leachate and groundwater separately.

EPA Response: If the pilot-testing discussed in the Phase III ROD demonstrates that it is cost-effective to treat groundwater and leachate separately, then design and operation of the treatment system(s) should follow accordingly. If treated separately, however, both leachate and groundwater must individually meet the target cleanup goals before being mixed together for discharge.

Comment 4. Solidification of Dunstable Brook sediments, prior to disposal in the landfill, is unnecessary.

EPA Response: Solidification of sediments provides for a more permanent remedy, and it satisfies CERCLA's statutory preference for treatment as a principle element. Also, depending on the season, solidification of sediments may be necessary to meet construction requirements for acceptable fill to be used in the capping project.

Comment 5. Details and projected costs of the deep bedrock groundwater "early warning" monitoring system should be provided.

EPA Response: The Phase III ROD describes the scope of the groundwater monitoring plan, and explains that more specific details of the plan will be developed during remedial design. Costs for the monitoring as presently projected are included in the ROD.

Comment 6. The time allowed for PRP and general public review of the Phase III Remedial Investigation study was inadequate.

EPA Response: The RI and the FS were distributed to the PRPs and placed in the public information repositories before the start of the public comment period. In fact, EPA finalized and distributed the FS before final printing of the RI in order to provide the PRPs and the public a chance to read the FS (which contained a discussion of the contamination detected during the Remedial Investigation) before the start of the comment period. The twenty one day comment period is consistent with the current National Contingency Plan (NCP).

Comment 7. Off-site disposal of leachate by trucking to a RCRA facility should be re-evaluated during the pilot studies.

EPA Response: Should off-site disposal of leachate to RCRA facility prove to be a viable option in the future, EPA will consider implementation of it.

Comment 8. The cleanup criteria for sediment removal of 1.0 part per million (ppm) for PAHs should be reconsidered. A 20 ppm level would result in a risk that would fall within EPA's target range of 1 x 10^{-4} to 1 x 10^{-7} for carcinogenic risk.

EPA Response: Under the worst realistic case, the carcinogenic risk (8.2 x 10^{-5}) associated with a target clean-up level of 20 ppm would be at the uppermost limit of the EPA target range. Because a target clean-up level of 1 ppm would result in a risk (4.1 x 10^{-6}) at the lower end of the range, it would be more protective of human health and the environment at the Charles George site.

Comment 9: The southwesterly sedimentation basin of the landfill cap should be relocated.

EPA Response: Appropriate engineering responses will be implemented to ensure that surface water from this sedimentation basin will not recharge the groundwater extraction system in the area.

Comment 10: Alternative methods of disposal should be considered for the contents of the landfill lagoons during Phase II cap construction.

EPA Response: EPA, together with the U.S. Army Corps of Engineers, will consider alternative methods for disposing of the lagoon contents. The possibility of using the proposed percolation pits as lined holding ponds will be investigated. This could allow for a source of pilot plant influent.

IV. REMAINING CONCERNS

During the public comment period, at the public informational meeting on August 3, 1988, and at the informal public hearing held in Tyngsborough on August 17, 1988, EPA representatives and local residents and officials discussed issues of community concern as the site moves into the design and implementation phase of EPA's selected remedies for the Charles George Landfill site. These issues and concerns are described briefly along with EPA comments on how the Agency intends to address these concerns.

(A) Sludge and Treatment Residuals

Citizens asked EPA to provide more exact figures on the expected amount of sludge to be generated by the water treatment plant along with detailed plans for disposal of the sludge.

EPA Response: The FS conservatively estimated that approximately 200 pounds per day of sludge from the biological treatment unit and 1400 pounds per day of sludge from the metals precipitation unit would be generated. As discussed previously in this responsiveness summary and in the ROD, on-site sludge disposal will occur only if found to be feasible and capable of meeting RCRA standards for hazardous waste disposal. These standards include extremely protective engineering requirements, including installation of at least two liners with leachate collection systems above and between each liner.

(B) Groundwater Quality

Citizens remain concerned that additional homes in the Charles George Landfill area may have contaminated wells. Citizens have asked EPA to further investigate wells in the vicinity of Flint Pond and provide an alternative water source to these homes.

EPA Response: As previously discussed, EPA will continue the residential well monitoring program, and will implement appropriate water supply responses if landfill contamination poses unacceptable risks to human health via groundwater.

(C) Leachate Storage Tanks

Citizens noted that possible emissions from the leachate storage tanks could contain VOCs, and stated that EPA should consider connecting the tanks to the landfill vent emissions incinerator.

EPA Response: During the Remedial Design phase, EPA will consider connecting the leachate storage tank emissions to the landfill vent emission incinerator system.

ATTACHMENT A

COMMUNITY RELATIONS ACTIVITIES
CONDUCTED AT THE
CHARLES GEORGE RECLAMATION TRUST LANDFILL SITE
IN TYNGSBOROUGH, MASSACHUSETTS

Community relations activities conducted to date for Phase III remedial activities at the Charles George Superfund site include:

- November 1986 - EPA released a fact sheet to inform the public about the preliminary findings of the Remedial Investigation (RI) and Endangerment Assessment.
- November 20, 1986 - EPA held a public informational meeting to discuss the preliminary findings of the RI and Endangerment Assessment.
- 1987 - On several occasions, EPA and DEQE staff have met with residents and local officials to discuss local concerns and remedial activities.
- August 1987 - EPA released a revised community relations plan to provide an update of community concerns and community relations and remedial activities.
- July 1988 - EPA issued a public notice to announce the time and place of the Feasibility Study (FS) public informational meeting for the site and to invite public comment on the FS and Proposed Plan.
- July 1988 - EPA mailed the Proposed Plan announcing EPA's preferred alternative for addressing contamination at the site to all those on the site mailing list.
- August 3, 1988 - EPA held a public informational meeting to discuss the results of the FS and the Proposed Plan.
- August 4 - August 24, 1988 - EPA held a public comment period on the Proposed Plan.
- August 17, 1988 - EPA held an informal public hearing to accept comments on the remedial alternatives evaluated in the FS and Proposed Plan.

UNITED STATES OF AMERICA

ENVIRONMENTAL PROTECTION AGENCY

BOSTON REGION

In the Matter of:

SUPERFUND PROGRAM)
)
CHARLES GEORGE RECLAMATION)
TRUST LANDFILL SITE)
TYNGSBOROUGH, MASSACHUSETTS)

Wednesday
August 17, 1988

Auditorium
Tyngsborough High School
50 Norris Road
Tyngsborough, Massachusetts

Whereupon the above entitled Matter came on for hearing pursuant to Notice at 7:50 P.M.

BEFORE:

RICH CAVAGNERO, Chief-Massachusetts Superfund Section

DAVE DICKERSON, Remedial Project Manager

DALE YOUNG, Massachusetts D.E.Q.E.

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I N D E X

SPEAKERS	PAGE
Richard A. Cavagnero	3
David Dickerson	5

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PROCEEDINGS

(7:50 p.m.)

MR. CAVAGNERO: We're going to get started, if everyone's ready. My name is Rich Cavagnero, I'm the Chief of the Massachusetts Superfund Section of EPA, and with me to my left, your right I guess, is Dave Dickerson, who's the Remedial Project Manager for the Charles George Land Reclamation Trust Site in Tyngsborough, and on my other side is Dale Young, who's our contact from the Massachusetts Department of Environmental Quality Engineering, DEQE.

The purpose of tonight's meeting is, for most of you who were here back on August 3rd, we had a public meeting at which Dave and E. C. Jordan, our contractors, explained the results of the feasibility study, what options had been looked at, and also EPA's proposed plan, that is what we're leaning towards as far as a remedy for the Charles George site.

We're here tonight to basically hear what you have to say about that proposed plan or the feasibility study. We have people from Apex Recording here who will be transcribing any comments made, and we'll be producing a transcript. This transcript will go into what we call the Administrative Record, which will be used, along with all the studies that EPA has done and the comments submitted by the State, and any written comments submitted prior to the close of the comm period on August 24th, and based on all this material, EPA will come to a final decision on a remedy at this site and will issue something called a Record of Decision, which will be a document that explains in some detail what we found at the site, what the problems are, what options were looked at, and why we chose the option we chose.

It will also include a portion called the Responsiveness summary, which will be a response to all comments submitted, either orally tonight at this hearing or written comments. So you have your choice, you can do either or both. And as I mentioned the last time we were here, we do feel it's necessary to get your comments because we do want to take them into account before we come to a final decision.

So to reiterate, the comment period does close on August 24th. In order for your comments to be considered before decision is made, we need them to our office, postmarked by that date or orally tonight.

Dave Dickerson will briefly rehash for you, although it seems to be the same people here, but once again he'll rehash EPA's preferred alternative, after which we will start the formal part of the hearing, if you will.

If you are going to make a statement, we would ask that you fill out one of the forms, just with your name and address, so that we make sure we get it right for the hearing transcript. And once all the statements are made, we'll close the hearing officially, and Dave and I and Dale will hang around and take questions and answers, if you have any.

So with that, I'll turn it over to Dave Dickerson.

MR. DICKERSON: Thank you, Rich.

Just to recap the proposed plan, if anyone wasn't here and needs an update, our proposal, basically, consists of three main parts, the treatment of groundwater and leachate, treatment of the landfill gas emissions, and the treatment of some contaminated stream sediments.

Taking the groundwater and leachate first, we propose to extract contaminated shallow groundwater from two areas near the landfill. One area is in the southwestern part of the landfill and the other area is on the eastern part of the landfill, right next to Route 3. Those two plumes would be combined with leachate collected as part of the capping system, and treated on site to drinking water standards.

After monitoring to make sure we met those standards, the treated groundwater and leachate would then be discharged into Dunstable Brook.

In addition to that groundwater and leachate treatment, we would have an upgrading in groundwater diversion trench that would lower the groundwater table beneath the landfill, and that water would also get diverted to Dunstable

Brook after monitoring, to make sure that it was still clean.

In addition, we would propose to monitor deep bedrock ground water as well as private drinking wells to make sure that people's wells were safe to drink.

To go into just a little bit of detail on the on-site treatment plant, it would be comprised of three, perhaps four treatment schemes. The first would be biological treatment, the second would be metals prescipitation, the third would be carbon adsorption, and if necessary, ion exchange, if we hadn't met our drinking water standards yet.

Moving on to the landfill gas emissions, we propose to collect the landfill gas from the 28 vents that will be installed as part of the capping system, pump those emissions to a fume incinerator on site and estroy the compounds of concern in the gas emissions in that incinerator.

Moving on to the stream sediments, contaminated sediments in a short section of Dunstable Brook to the west of the landfill would be dredged, brought to the site, solidified, using cement-like substance, placed on the landfill, and covered as part of the landfill with the synthetic landfill cap.

So that's a very, very brief description of the proposed plan. Again, it's treatment of groundwater and leachate, air emissions, and some stream sediments.

Rich?

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MR. CAVAGNERO: Thank you, Dave. We will now, basically, open the hearing to comments. We would ask that if you want to make a comment, if you could come down to the mike, which is not an amplifier but is hooked up to Apex Recording, so that we make sure that we get your statement right, and we would like you to identify yourself by name and address and any affiliation, if you have one.

(Pause.)

MR. CAVAGNERO: Well, no one wants to make a comment, it's going to be a short hearing.

Okay. We do have your option of sending it to us in writing, and we hope that we will hear from you. David's address is in the fact sheet, and proposed plan, we do have some handouts here, I believe most of you are probably on the mailing list and have that.

The administrative record is located at the Littlefield Library, and there are copies of the feasibility study and proposed plan at both the Littlefield Library and Tyngsborough Board of Health, as well as at out office, EPA's office at Canal Street in Boston.

So if there are no comments, my first time ever at a hearing where we had none, but we will close the hearing and entertain any questions that anybody may have.

(Whereupon, at 7:58 p.m., the hearing was concluded.)

CERTIFICATE OF REPORTER AND TRANSCRIBER

This is to certify that the attached proceedings

before: ENVIRONMENTAL PROTECTION AGENCY

in the Matter of:

SUPERFUND PROGRAM

CHARLES GEORGE RECLAMATION
TRUST LANDFILL SITE
TYNGSBOROUGH, MASSACHUSETTS

Place: Tyngsborough, Massachusetts

Date: August 17, 1988

were held as herein appears, and that this is the true, accurate and complete transcript prepared from the notes and/or recordings taken of the above titled proceeding.

V. Rasmussen
Reporter

8/23/88
Date

J. Rasmussen
Transcriber

8/23/88
Date

APPENDIX B

NEWSWEEKLY, THURSDAY, JULY 28, 1988

The United States Environmental Protection Agency
Invites Public Comment
On the Phase III Feasibility Study And Proposed Plan
For The
Charles George Reclamation Trust Landfill Superfund Site
In
Tyngsborough, Massachusetts
And Announces The Availability Of the Site Administrative Record

The U.S. Environmental Protection Agency (EPA) recently completed a Phase III Feasibility Study (FS) that evaluated cleanup alternatives to address contamination at the Charles George site in Tyngsborough, Massachusetts. The Phase III FS evaluated alternatives to address contamination in leachate and gas emissions at the site as well as alternatives to address contamination in off-site areas. Based on the Phase III FS, EPA has selected a preferred cleanup alternative for the site. EPA invites public comment on all of the alternatives evaluated in the FS and the preferred alternative described in EPA's Proposed Plan.

EPA will host a **public informational meeting on August 3, 1988 at 7:30 p.m.** at the Tyngsborough High School (located at 50 Norris Road in Tyngsborough) to describe the FS and the preferred alternative and to answer questions. Results of the Phase III Remedial Investigation also will be discussed at this meeting. EPA will hold a **three-week public comment period from August 4 through August 24, 1988** to provide an opportunity for the public to participate in the selection of a final cleanup plan. The public is invited to review the Proposed Plan, the RI, and the FS (available at the information repositories listed below) and to offer written or oral comment to EPA during the comment period. EPA will hold a **public hearing on August 17, 1988 at 7:30 p.m.** at the Tyngsborough High School to accept oral comments on the FS and Proposed Plan. The hearing will be transcribed and a copy of the transcript will be available at the information repositories.

The Phase III FS evaluated five alternatives to address leachate and groundwater contamination, four alternatives to address contamination in landfill gas emissions, and seven alternatives to address contamination in off-site sediments. These alternatives are:

Leachate and Groundwater
1) Biological Treatment and Carbon Adsorption
2) Carbon Adsorption
3) Air Stripping and Carbon Adsorption
4) Off-Site Treatment
5) No Action

Landfill Gas Emissions
6) Incineration
7) Gas Flaring
8) Combustion/Medium Btu Gas Recovery
9) No Action

Sediments
10) Excavation, On-site Solidification, and Disposal
11) In-situ Capping
12) Excavation, Thermal Aeration, and Disposal
13) Excavation, Off-site Solidification, and Disposal
14) Excavation, Off-site Incineration, and Disposal
15) Excavation and On-site Disposal
16) No Action

EPA's preferred alternative is a three part plan, composed of alternatives #1, #6, and #10 listed above. Biological Treatment and Carbon Adsorption would entail extracting shallow groundwater from the southwestern and eastern areas of the landfill and treating the groundwater, along with landfill leachate, in a treatment system using the following four treatment processes to remove organic compounds and metals: biological treatment; precipitation; carbon adsorption; and ion exchange. Treated groundwater and leachate would be discharged to Dunstable Brook. In addition, a program would be implemented to monitor deep bedrock groundwater to ensure that it does not pose a risk to drinking wells.

Incineration of landfill gas emissions would entail collecting all emissions from the

The Phase III FS evaluated five alternatives to address leachate and groundwater contamination, four alternatives to address contamination in landfill gas emissions, and seven alternatives to address contamination in off-site sediments. These alternatives are:

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Sediments
10) Excavation, On-site Solidification, and Disposal
11) In-situ Capping
12) Excavation, Thermal Aeration, and Disposal
13) Excavation, Off-site Solidification, and Disposal
14) Excavation, Off-site Incineration, and Disposal
15) Excavation and On-site Disposal
16) No Action

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Incineration of landfill gas emissions would entail collecting all emissions from the landfill gas vents and treating them in an on-site incinerator. Excavation, solidification, and disposal of sediments would entail excavating approximately 500 cubic yards of contaminated sediments from Dunstable Brook and from a tributary that flows into Dunstable Brook from the western side of the landfill. The excavated sediments would be solidified in an on-site facility and then disposed underneath the landfill cap that EPA will begin constructing at the site in 1989. The preferred alternative is described in detail in EPA's Proposed Plan.

The Proposed Plan, the Phase III FS, and other site-related documents are available for review at the following information repositories:

Tyngsborough Board of Health
Tyngsborough Town Hall
10 Kendall Road
Tyngsborough, MA 01879
(508) 649-7441
Mon-Fri: 9:00 a.m. - 12
1:00 p.m. - 4:00 p.m.

Littlefield Public Library
252 Middlesex Road
Tyngsborough, MA 01879
(508) 649-7361
Tues. and Fri.: 9:00 a.m. - 4:00 p.m.
Wed.: 9:00 a.m. - 9:00 p.m.
Thurs.: 9:00 a.m. - 4:00 p.m.
7:00 p.m. - 9:00 p.m.

EPA Records Center
90 Canal Street, 1st Floor
Boston, MA 02108
(617) 573-5729
Mon. - Fri.: 8:30 a.m. - 1:00 p.m., 2:00 - 5:00 p.m.

In addition, EPA has compiled the Administrative Record for the Charles George site. The Administrative Record contains all of the documents and reports prepared to date that have been and will be used by EPA and the Massachusetts Department of Environmental Quality Engineering as the basis for selecting cleanup remedies for the site. The Administrative Record will be available for public review by August 1, 1988 at the Littlefield Public Library and the EPA Records Center *(addresses listed above)*.

If you would like to comment in writing on the FS or EPA's Proposed Plan, please mail your written comments *(postmarked no later than August 24)* to:

David Dickerson, Remedial Project Manager
U.S. Environmental Protection Agency, Region I
Waste Management Division
J.F.K. Federal Building (HRS-CAN3)
Boston, MA 02203-2211
(617) 573-5735

APPENDIX C

The Commonwealth of Massachusetts
Executive Office of Environmental Affairs
Department of Environmental Quality Engineering
Division of Hazardous Waste
One Winter Street, Boston, Mass. 02108

Daniel S. Greenbaum
Commissioner

Sept. 28, 1988

Michael R. Deland
Regional Administrator
U.S., E.P.A.
JFK Federal Building
Boston, MA 02203

Re: Tyngsboro-Concurrence with ROD
for Charles George Landfill
Federal Superfund Site

Dear Mr. Deland:

The Department of Environmental Quality Engineering (the Department) has reviewed the preferred remedial action alternative recommended by EPA for management of off-site migration at the Charles George Landfill federal Superfund site. The Department concurs with the selection of the preferred alternative for the site.

The Department has evaluated EPA's preferred alternative for consistency with M.G.L. Chapter 21E as amended in November, 1986, and the Massachusetts Contingency Plan (MCP). The preferred alternative addresses the final two phases or operable units for clean-up at the site and includes the following three components:

(1) combined treatment of landfill leachate and groundwater,
(2) incineration of landfill gas emissions, and
(3) excavation, solidification, and disposal of sediments.

The Department has determined that the preferred alternative is not a permanent remedy as defined in M.G.L. c. 21E and the MCP due to the exceedance of the Total Site Carcinogenic Risk Limits. The preferred remedy, however, would be considered a temporary solution if institutional controls are used to prevent future use of contaminated groundwater. The Department therefore recommends that institutional controls be used to prevent future use of the contaminated groundwater.

As the preferred remedy is a temporary solution, the MCP requires that a Final Remedial Response Plan (FRRP) be prepared for the identification and development of a feasible permanent solution. As part of the FRRP, the Department anticipates evaluating the effectiveness of both the groundwater monitoring program and the institutional control provisions. These programs may, in time,

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indicate the need for further remedial action or that a permanent solution has been achieved if the Total Site Risks are demonstrated to meet the MCP risk limits.

The proposed remedy appears to meet all ARARs. The Department will continue to evaluate the ARARs as remedial design progresses and during implementation and operation of the remedy.

The Department looks forward to working with you in implementing the preferred alternative. If you have any questions or require additional information, please contact Dale Young at 292-5785.

Very truly yours,

Daniel S. Greenbaum, Commissioner
Department of Environmental
Quality Engineering

DY/sc:lgw

Edmond Benoit, DEQE/CRO